THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE

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ELECTRIC SUPPLY COMPANIES AND THE LAW OF NUISANCE.

THE case of Knight *v.* The Isle of Wight Electric Light and Power Co., the full judgment in which is reported in another column of the present issue, involves a question of the gravest importance to electric light and power companies.

To read the terms of the injunction is to realise that it will be fraught with serious consequences to the defendant company. Its full effect, however, will only be appreciated when it comes into force. It may be that, by ceasing to use producer gas engines, the noise and smell will be sufficiently diminished, but apparently the company are unable, owing to the terms of their lease, to erect a chimney stack and generate by means of steam engines. Even if they could adopt this course, it would probably cost them less to buy up the plaintiff's school and pay her heavy compensation in addition.

While we do not doubt for a moment that the conclusions of fact at which the learned judge arrived are fully justified, we regret that he should have felt himself compelled to lay down the law in a manner so unfavourable to the defendants. We have often contended that the law of nuisance is somewhat harsh in so far as electric light and power companies are concerned; in the execution of their powers the protection afforded to them is not nearly so valuable as the protection enjoyed by a railway company. Did the company serve a more private interest it is obvious that they should be compelled to generate electricity in strict accord with the private rights of their neighbours, but electricity is supplied for the common use of the inhabitants of a district. Further, although it may be said with some show of reason, that an electric lighting company have to watch the interests of their shareholders, no such argument can be used where the undertaking is in the hands of the local authority.

That there is some prospect of a change in the law affecting the liability of an electric lighting company for nuisance, appears from a report of the Joint Select Committee of the House of Lords, which was appointed to consider the subject of generating stations and supply in 1898. One of the questions submitted to the Committee was the following:—

"Whether, notwithstanding the provisions of Sec. 12 (1) of the Electric Lighting Act, 1882 [which excepts the enactments of the Lands Clauses Acts relating to compulsory purchase from application to electric lighting—EDS.], powers should be given in any case for acquiring land compulsorily for generating stations; and, if so, under what conditions as respects liability for nuisance, notices to surrounding owners, and otherwise?" To this question the Committee replied:—"With respect to liability for nuisance, they are of opinion that where the site of a generating station is acquired under compulsory powers, and is specified in the Provisional Order or special Act, the under-

takers should not be subjected to any further liability than that which, according to Lord Blackburn (Geddis *v.* Bann Reservoir, 3 A.C. 455) is imposed by the common law, in the case of persons exercising statutory powers and duties. On the other hand, where the site for a generating station is acquired by agreement, they think the undertakers ought to be subject to the liability imposed by the common law."

In Geddis *v.* Bann Reservoir (*ubi. supra.*), Lord Blackburn said: "It is now thoroughly well established that no action will lie for doing that which the Legislature has authorised, if it be done without negligence, although it does occasion harm to anyone; but an action does lie for doing that which the Legislature has authorised, if it be done negligently. And I think that if, by a reasonable exercise of the powers, either given by statute to the promoters or which they have at common law, the damage could be prevented, it is, within this rule, negligence not to make such reasonable use of their powers."

In our view, the above principle might be applied to every generating station, whether built on land acquired compulsorily or otherwise.

It would be competent for the Court, in all the circumstances, to say what was negligence, and in solving that question the Judge could take into consideration all the difficulties under which the company might have laboured in obtaining a particular site.

Trolley Wire Breaks.

It is as well for our readers—and particularly those who are associated with the operation of electric tramway systems—to keep themselves posted in regard to responsibility for overhead-wire mishaps. Therefore, we direct attention to a consideration of the legal aspect from the pen of a qualified lawyer, which appears on another page of this issue, and to the report of the decision in the appeal case of the Sunderland Corporation in which it is argued that negligence, and nothing else, can be blamed for the breakage of the wire which caused the claimant against the Corporation to receive bodily injury, and an electric shock.

It behoves tramway authorities generally to see that overhead work is subjected to frequent and rigorous inspection, and, may we add, that there be no dilatoriness in remedying any defects which may be discovered in the course of such examinations. The fact that a line has been passed by the Board of Trade cannot be construed to mean that, therefore, it will always remain in such a condition as to ensure the safety of the public or the continuity of the system. We believe that there are some of our tramway authorities—we do not say whether companies or municipalities—who, if they are honest with themselves, will have to confess that their attention to this matter has not been all that it should have been in the past.

Borough Councils and the M.E.A.

The London Borough Councils, who are now being invited to the ninth annual convention of the Incorporated Municipal Electrical Association at Derby next summer, seem, judging from the discussions and decisions arrived at, indisposed to continue their membership of the Association owing to fear of surcharge of the guinea subscription by the auditor. The subscription became due on the 18th of this month. The auditors surcharged the amount last year, but while the Local Government Board subsequently sanctioned it, the Borough Councils were informed that the Board could not undertake to withdraw any future similar expenditure from the district auditor's jurisdiction. Under these circumstances the Councils do not care to continue the subscriptions, although it is admitted that membership of the Association is of considerable value to the Electricity Committees. The disabilities from which the London Borough Councils suffer in regard to membership of various municipal associations and societies are causing considerable irritation.

Municipal Blackmail.

The recent action of the Brentford Urban District Council in refusing to give its consent to the establishment of a tramway extension between Ealing and Brentford illustrates the difficulties with which electric tramway companies have to contend in suiting the convenience of the public. We have said that it refused its consent. In reality the answer to the request of the company, which the Council is pleased to call a "concession," imposed the following conditions, *inter alia*:—

(1) That the London United Tramways Co. should erect and maintain a public lavatory near Kew Bridge; (2) that they should build or erect a subway at the same place; (3) that they should widen the highway for a considerable distance to a width of 80 ft.; (4) that they should pay an annual sum of at least £1,000 to the Council; and (5) that the road along which it was proposed to lay the new line should be made at least 80 ft. wide.

As a result of these restrictions, the company have been compelled to abandon an undertaking which never promised to be very profitable, but which became financially impossible when carried out subject to these onerous terms. When it is remembered that the Council would have been relieved of the cost of paving and maintaining the greater part of the street along which it was proposed to make the new line, the real fatuity of the Council becomes apparent. This is not the first time that the Council has come into conflict with the company. In April, 1901, it brought an action for a declaration that the company were not entitled to commence the construction of Tramway No. 7 of their system, within the plaintiff's district, until they had complied with the requirements of the Tramways Act, 1870. That action was dismissed with costs (see Electrical Review, April 5th, 1901, p. 579).

Tramways and Light Railways.

We have often had occasion to refer to the unreasonable nature of a statute which provides that a local authority may withhold its consent *mero motu—i.e.*, without giving any reason for so doing. It is also unfortunate that it is competent for a local authority to impose terms. That they can do so was decided in the case of the Attorney-General *v.* Hastings Corporation, 1902 (19 T.L.R. 9). There a local authority made an agreement with an individual that they should call on him to apply for powers to make a certain tramway when they deemed such tramway necessary, and that he, if he obtained such powers, should pay them certain wayleaves for the use of the tramway. They also agreed that they would not consent to the application by anyone else for such powers, without first calling upon the other party to the agreement to apply for the powers. This agreement was held to be *ultra vires* of the local authority. But would the tramway companies have a loophole of escape? While the consent of the local authority is practically a *sine quâ non* for the establishment of a tramway, a light railway may be established without such consent, the stipulation in Sec. 7 (1) of the Light Railways Act, 1896 (59 and 60 Vict., c. 48) being that the local authority must be *consulted* before the application is made to the Commissioners. A statement of their assent or dissent must, however, accompany an application to the Light Railway Commissioners. According to Mr. Robertson's valuable work on "Tramways and Light Railways," "The intention of this Act is that the local and road authorities should not have power of preventing the authorisation of a scheme, but their opposition, as being the opposition of the general representatives of the districts through which the railways are to pass, has great weight with the Commissioners, and, except under special circumstances, may prove fatal to the scheme." This is probably an accurate statement of the case; but we wonder what the Light Railway Commissioners would say to the conditions imposed by the Brentford Urban District Council?

ELECTRIC TRACTION AND ALTERNATING CURRENTS.

"Coming events cast their shadows before." The great interest everywhere exhibited in the application of alternating currents to heavy railway traction, and the experiments now being carried out by some of the largest manufacturing concerns, as well as the difficulties which oppose the adoption of continuous current motors on our main line railways, are sufficient evidence that engineers have realised that if the adoption of electric traction on our main line railways is ever to be realised, a commercial alternating current motor is an absolute necessity. Mr. Westinghouse, than whom no one is more awake to the conditions and requirements of railway work, has recently emphasised the great disadvantages possessed by the continuous motor, as far as its application to main line railway work is concerned.

The history of electricity is a tale of obstacles surmounted. No sooner has a serious difficulty arisen in the adaptation of electricity to any particular purpose, than the brains and energy of the manufacturing interests have resolutely attacked the problem, and a solution has generally been found for what has been dismissed by wiseacres as "impossible."

For some years the European engineers have been attempting to apply alternating currents to traction purposes, and they have mostly been successful in obtaining satisfactory results as far as they have gone.

American engineers have at last realised the difficulties of the application to most of the railway systems in this country, of the continuous current system, and this is fully demonstrated by the number of papers on alternating current traction systems, which have recently been read before the various engineering societies of America.

We have before us, as we write, three papers on this particular subject, which were read at the meeting of the Canadian Society of Civil Engineers, on November 19th of last year, and their titles are sufficiently suggestive:—(1) "Notes on Polyphase Equipments of some European High-Speed Electric Railways," by L. A. Herdt. (2) "Inter-Urban Electric Traction Systems, A.C. *v.* D.C.," by P. M. Lincoln. (3) "Some Possibilities of the Alternating Current Single-Phase Railway Motor," by A. H. Armstrong.

As usual, with the characteristic modesty of the American engineer, they claim electric traction as entirely of American origin and peculiar to that country. That the Americans, under special local conditions and requirements, have done a great deal to promote electric traction, and that there are a larger number of electric tramways in that country than anywhere else, is undoubtedly true. At the same time, we would repeat what we have often mentioned, viz., that electric traction was primarily a European invention, and that the first electric tramway was operated by Siemens at the Berlin Electrical Exhibition in 1879.

The first practical applications of electric traction took place at Berlin, at Portrush, and at Blackpool and Brighton. Even in the first application of electric traction to heavy railway work, the City and South London Tube and the Liverpool Overhead can both claim priority to the intramural line at the World's Fair at Chicago in 1893.

The first serious attempt at the introduction of alternating current for traction purposes on railways was made many years ago by an enterprising Swiss firm (Messrs. Brown, Boveri et Cie.) in connection with the Lugano three-phase tramways, which are still operating most successfully; this achievement encouraged the firm so much that they have since equipped a large number of mountain and other railways, the most important of which is the line between Burgdorf and Thun. In practically all these cases, water-powers were available and the gradients encountered very severe. It was no doubt in consequence of the success of these that Messrs. Ganz & Co. investigated the subject, and designed their well-known system, now in operation on the Italian Lakes. Notwithstanding these successes, we do not think that such systems could ever be seriously considered in connection with the electrification of main lines, much less of suburban sections.

A careful study of the conditions that obtain in railway work, both in this country and on the Continent, has clearly demonstrated the impossibility of using the third rail in many situations, and the problem is further complicated by the very large amount of power required to operate heavy trains at high speeds, which means very heavy currents if continuous-current motors are used. These and other similar reasons which we have not space to discuss in the present article, have made it evident that if electric traction on main line railways is to be a success, single-phase alternating-current motors must be used in connection with overhead conductors.

No engineer who has given the matter serious thought can fail to see that if a satisfactory single-phase motor for traction purposes could be designed, that, undoubtedly, would be the ideal solution. Professors and engineers without large practical experience, have from time to time in the past used this fact as an argument in favour of the adoption of costly and inefficient systems, such as the Ward Leonard, which we cannot think could ever be practically successful; it is this reason which has up to the present made it impossible for any responsible engineer to seriously advise any railway to install a single-phase system; if electric traction had to be used, the only one which could at all reasonably be employed was the third rail continuous-current system adopted by the Metropolitan District, and the North-Eastern and Lancashire and Yorkshire Companies.

When the Lamme system was first brought forward, and it was stated that a line between Washington and Annapolis was going to be equipped, we pointed out the important bearing that this line, if successful, would have on the electrical equipment of railways in this country. Since that time, investigation has shown that several engineers and electrical firms have been experimenting with a view to producing a satisfactory single-phase motor. Dr. Finzi, in Italy, commenced his experiments many years ago, and we think we are right in stating that he was the pioneer in this direction. The Westinghouse Co. in the States have now progressed sufficiently to state their willingness to enter into contracts for equipping railways with alternating current motors. The General Electric Co., of America, have brought out what is known as "the Thomson repulsion motor." M. Latour, in France, has been writing on the results which may be expected, and which he claims he can realise if his motor is constructed; and the U.E.G., of Berlin, have constructed and are operating motors on railways, with results so satisfactory that they are well-nigh incredible.

Of the three papers before us, the first, "Notes on Polyphase Equipments of Some High-speed Electric Railways," practically limits itself to a description of the Ganz and the Berlin—Zossen high-speed lines. These systems have already been described in these pages, and any further reference to this particular paper, except to point out the proof that it brings of the interest shown in alternating current railways in America, is, therefore, unnecessary.

The second paper, "Interurban Electric Traction Systems: A.C. *versus* D.C.," by P. M. Lincoln, has several points of interest, although its tone is rather egotistical, the author claiming that electric traction is peculiarly an American institution. He goes on to say:—

American engineers have consistently refused to adopt the polyphase induction motor for traction purposes, on the ground that it is not suitable for that purpose. The principal reasons for this stand are two in number—

1. That the polyphase induction motor is inherently a constant-speed motor, and therefore not adapted to traction purposes. Continual change of speed is one of the characteristics of traction work. . . . At one definite speed the polyphase motor is an efficient machine, while at all other speeds the efficiency can not be greater than the ratio of the actual speed to the synchronous speed. . . . In traction work a large part of the work done is necessarily at speeds below the maximum attained, and at these lower speeds the maximum economy that can be obtained from induction motors is necessarily small.

2. The second reason against the use of polyphase induction motors for traction purposes is the necessity for providing at least two overhead conductors. If the track be not used as one of the conductors, then the necessity arises of using at least three overhead conductors. Maintenance of insulation on such overhead conductors when they are at high voltage is naturally a difficult problem, much more difficult than to maintain the insulation between a single conductor and ground, as would be the case in the single-phase system.

The principal advantages of the alternating-current electric traction over the direct current are as follows:—

1. Limits to trolley voltage are removed.

2. Avoidance of rheostatic losses.
3. The necessity of rotary converter sub-stations abolished.
4. Manual attendance at the sub-stations done away with.
5. Danger of electrolysis by return current avoided.

Another point which militates against the use of direct current is the fact that, when large units are used, it is difficult to collect the large amount of current for their operation. For this reason, as well as an advantage in cost, trolley construction has been largely replaced by third-rail for inter-urban work. By raising the voltage of the secondary system, the current taken by the locomotive may be reduced, and, consequently, the difficulty with collecting devices may be made to disappear.

We fully endorse the sentiments expressed in the abstracts quoted in this paper, in which the writer has stated the facts very clearly. The disadvantages which he puts forward, however, appear to us very light in comparison with the very solid advantages to be gained. As regards interference with telegraphs and telephones, greatly reduced currents will probably more than compensate for the use of alternating instead of continuous currents, and, indeed, experiments seem to bear out our view.

In this same paper a comparison is made of the electrical equipment and working costs of a 60-mile line equipped for direct and single-phase currents; from the mass of figures given the following principal items have been extracted:—

Direct-Current System.	Single-Phase System.
20,000 v. polyphase feeders, sub-stations with static transformers and rotary converters, line voltage 550, and 60-lb. conductor rail. Twelve-car equipments.	20,000 v. feeders, sub-stations with static transformers, trolley voltage 3,000, and trolley wire 4/0 B. & S. Twelve-car equipments.

Capital Costs.

Power station	£6,515	Power station	£6,460
Feeders	9,140	Feeders	11,920
Sub-stations	10,820	Sub-stations	4,760
Line	36,540	Line	18,270
Car equipment ...	12,521	Car equipment ...	20,357
Total ...	£75,536	Total ...	£61,767

Annual Working Costs.

D.C. total	£11,061	A.C. total	£10,251
D.C. Extras.		A.C. Extras.	
Sub-station attendants	£1,440	Feeders maintenance	£139
Fuel, water, oil, &c. ...	280	Line conductor maintenance	366
Power-house maintenance, &c.	0	Car equipments, maintenance	533
Sub-stations, maintenance, &c.	127		
	£1,847		£1,038

Thus the annual balance to the credit of the A.C. system is £809.

The above figures show that with the line Mr. Lincoln considers the capital of the A.C. system works out at approximately 82 per cent. of that of the D.C. system. The working expenses of the A.C. system amount to about 92 per cent. of those for continuous current.

The figures presumably refer to the Westinghouse equipments, but results of the other proposed systems will, we think, show that if anything, the cost, both as regards capital and working expenses, has been over estimated, while the saving will probably be even greater than that which Mr. Lincoln anticipates. Even if the total capital cost and working expenses were the same for both systems, the alternating current system, owing to the difficulties which we have already referred to, will be the only solution as regards the general adoption of electric traction on our railways.

The third paper, entitled "Some Possibilities of the Alternating Current Single-Phase Railway Motor," by A. H. Armstrong, is one which is of great importance as coming from an engineer connected with the General Electric Co. The conclusions arrived at are practically identical with those in the paper previously referred to, and this fact is highly significant, as showing that the two American manufacturers concerned have practically pinned their faith to single-phase electric traction, which hitherto they have strenuously opposed. Hence the fact that they have each come into the field with a practical single-phase motor, is, therefore, under the circumstances, exceedingly satisfactory. Mr. Armstrong's statement is especially interesting; we quote from his paper:—

> During the past few years there have been developed several types of alternating current motors having speed-torque characteristics even better adapted for railway work than that of the direct current series motor, and, furthermore, providing ample starting torque with any voltage variation liable to occur in practical electrical railway operation. As these motors can be operated with a single trolley and ground return, and can, furthermore, be operated satisfactorily on either direct or alternating current, it makes their field of usefulness much greater than their direct current series competitor.
>
> Having such a motor, with practically no restriction as to voltage, it is possible to break away from the exclusive field of electric traction with frequent service and small units, and consider the operation of freight and passenger trains over our regular steam lines.

The result of Mr. Armstrong's series of calculations, worked out per mile of single track for various services of trains per day, and for trains of different weights, is one which we should have anticipated. As he says, it

> Brings out the fact that for very infrequent service, that is, five trains per day each way or less, it would hardly pay to equip the road electrically, there being a dividend of from 4 to 7 per cent. on the capital invested. With more frequent service, however, the saving in electrical operation becomes more marked, until at from 15 to 20 trains per day each way, the interest-earning power of the electrical investment is worthy of very careful consideration. *It should be borne in mind that all these figures do not contemplate increase in the present traffic of the road, and, therefore, do not take into consideration one of the chief characteristics of electric traction, that is, developing short haul local traffic, and thus increasing the dividends by increasing the receipts rather than by cutting down operating expenses.* (The italics are ours.)
>
> The well-known ability of electric roads to greatly increase previous steam traffic has led them to be installed, in many cases, without too close an investigation into their economical installation. . . . . The electrically-equipped road, while caring for the heavy through freight traffic with an earning capacity of from 4 to 7 per cent. on the investment, can also build up a local traffic, both freight and passenger, with practically no additional cost, and showing very large returns.

Mr. Armstrong draws attention to the interesting fact that the electric locomotive is considerably lighter than its steam competitor, and also that a steam locomotive, including the tender, has not more than 50 per cent. of its weight on the driving wheels, constituting from 7 per cent. to 10 per cent. of the total train weight. This proportion has been enormously increased by electric traction, particularly where electric motor-cars are used.

We fully agree with Mr. Armstrong when he states that "if all the factors entering into the engineering expense of operating roads by steam and by electric locomotives be carefully considered, the possibilities opened up by the use of the alternating motor are sufficiently great to warrant its replacing the steam locomotive in many of our railway systems, either in part or for the complete system."

As we have pointed out at the commencement of this article, the importance of these papers lies in the fact that they fully corroborate the experience which has been gained by the U.E.G. in Berlin, the results of the experiments carried out by Dr. Finzi, in Milan, and the theories of Monsieur Latour, in France.

It is at the present moment most encouraging to see how great a step has been made in the right direction, and everything tends to foster the hope that we shall shortly be able to employ standard and well tried single-phase alternating-current traction motors and controlling devices, exactly as we do to-day in the case of continuous-current apparatus.

We have constantly expressed our opinion that unless our railway companies are willing to lose their suburban traffic entirely, and practically to sink the enormous capital invested in stations and lines which are only used by local trains, they will have to adopt electric traction. The present experiments with single-phase motors are not only making the way easier for the railways, but at the same time they bring within the range of possibility the electrification of some of our main lines; this latter is, however, still a long way off, and the problem should not be attacked until the electrification of suburban lines by means of single-phase current has proved a success. That electrically-operated long distance lines are possible, we do not doubt for one moment, but whether they are financially justified at the present, we venture to question.

Heavitree Lighting.—The National Electric Construction Co. has submitted terms for the provision of electric light in the U.D.

ALTERNATING CURRENT GENERATORS GIVING PURE SINE WAVES OF ELECTROMOTIVE FORCE.

By CLIFFORD C. PATERSON.

The production of pure sine waves of electromotive force in alternating current machines has long been a subject of study and investigation. Although, when loaded, the wave form of a generator may approximate very nearly to that of a sine curve, on open circuit it is nearly always found to be peaky. The effect of a condenser load being to magnify these higher harmonics, a considerably increased stress is put upon the insulation of cables and machines.

In view of this, the recent progress made in the production of pure sine waves of electromotive force in alternating current generators is of considerable interest.

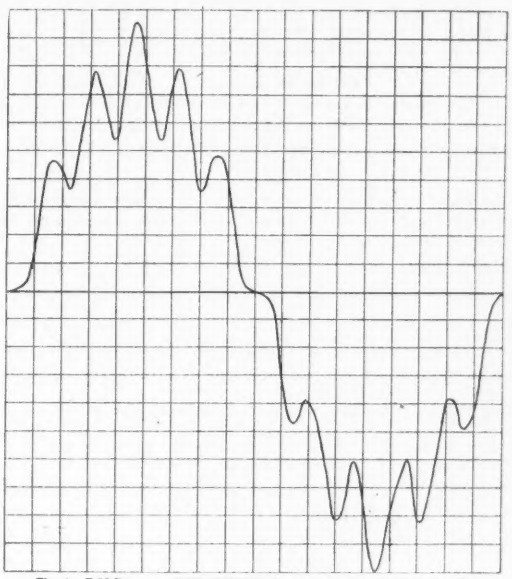


Fig. 1.—E.M.F. wave of 100-K.V.A. 3-phase generator on open circuit. Normal pole shape. 3,500 volts.

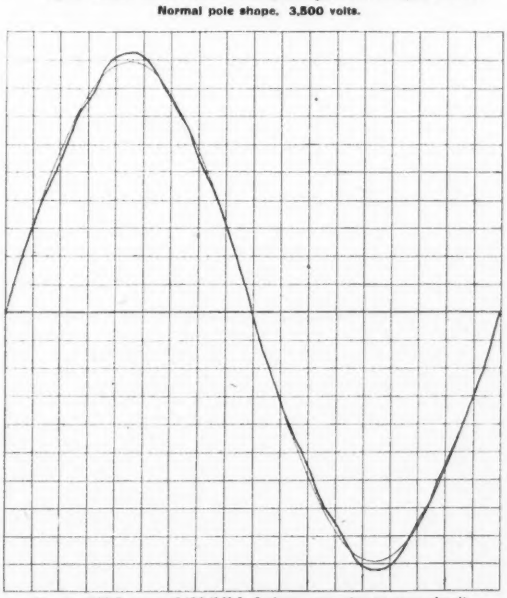


Fig. 2.—E.M.F. wave of 100-K.V.A. 3-phase generator on open circuit. New pole form. 3,500 volts.

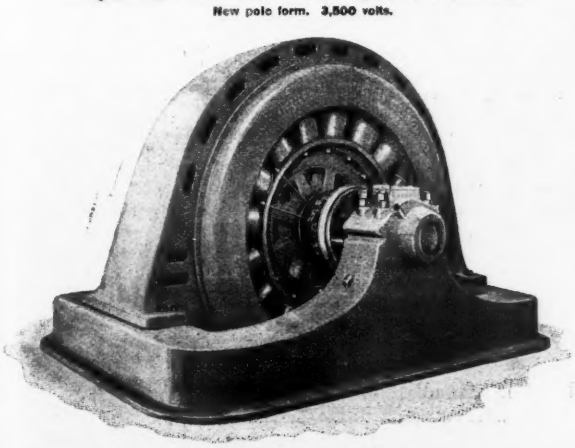


Fig. 3.—800-kw. Three-phase Generator, 13,500 Volts.

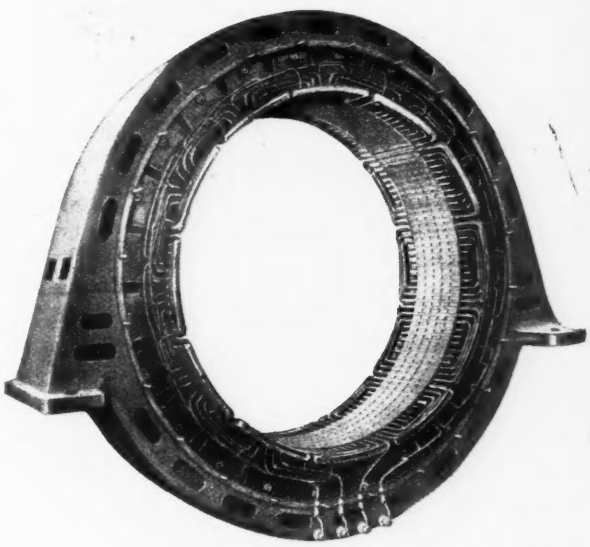


Fig. 4.—Stator of 800-kw. Three-phase Generator, 13,500 Volts.

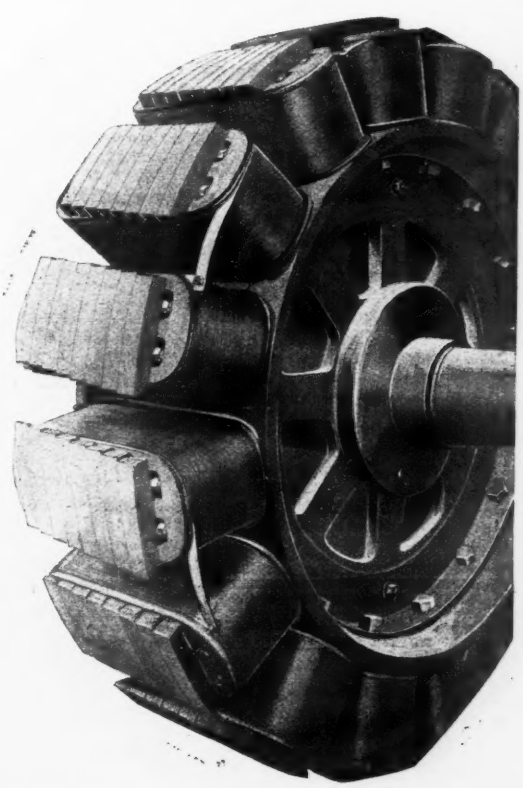


Fig. 5.—Pole-wheel of 800-kw. Generator showing New Type of Pole.

As long ago as 1891, the Maschinenfabrik Oerlikon, in Switzerland, built the well-known generators for the experiment of power transmission between Lauffen and Frank-

fort.* These were the first machines made with their pole-pieces set at an angle to the axis of the pole-wheel, the wave of electromotive force being very nearly a sine curve.

The same firm is now building generators on this principle, and the accompanying curves show the great improvement in wave form brought about by the employment of this type of pole.

Figs. 1 and 2 show the open circuit curves from a generator fitted first with the old and then with the new type of pole, the second curve in fig. 2 being the equivalent pure sine wave. These curves were taken in the testing department in Oerlikon, with the object of investigating the effects produced on the E.M.F. wave by various pole shapes. They have kindly been lent by the Maschinenfabrik Oerlikon for publication.

The photographs shown in figs. 3, 4 and 5, are those of an 800-K.V.A. three-phase generator of 13,500 volts with three slots per pole per phase, and 350 r.p.m. Fig. 5 shows the special pole construction. The iron is laminated throughout, the stampings being arranged in such a way

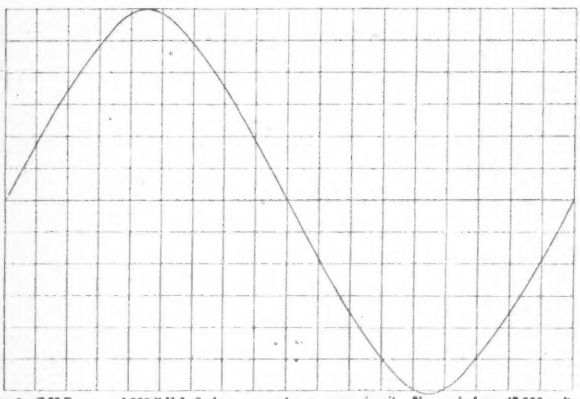


Fig. 6.—E.M.F. wave of 800-K.V.A. 3-phase generator on open circuit. New pole form. 13,500 volts.

that the polar edge makes an angle with the axis of the wheel. It will readily be seen how the distribution of flux with relation to the stator conductors tends to produce the desired effect.

Fig. 6 shows the curve of E.M.F. given by this machine on open circuit. It can hardly be distinguished from a sine wave.

By the employment of this type of pole all the dangerous harmonics disappear from the E.M.F. wave, and badly distorted wave shapes, which are otherwise inevitable on certain loads, now become impossible.

MAGNETIC DISPERSION IN INDUCTION MOTORS.†

The dispersion coefficient, σ, is defined by the expression—

$$\sigma = 1 - \frac{M_1 M_2}{L_1 L_2},$$

where M_1 and M_2 are the coefficients of mutual induction, and L_1 and L_2 the coefficients of self-induction of the primary and secondary windings respectively. The coefficient σ may be obtained experimentally as the ratio of the magnetising current to the short-circuit current at equal terminal potential differences.

The dispersion coefficient may be regarded as the sum of three distinct coefficients, viz:—

1. The winding coefficient.
2. Peripheral dispersion.
3. Flank dispersion.

The Winding Coefficient.—In every motor there exists a difference between the self-induction of the winding of one system and the mutual induction between corresponding portions of the windings of the primary and secondary systems, even if there were no so-called magnetic leakage to influence the relation.

To understand this we must remember that mutual induction is the sum of the products of the magnetic lines by the number of conductors interlinked by each. Even if no magnetic line produced by the primary current fails to interlink with the secondary circuit, the number of times it interlinks the secondary circuits depends upon the relative positions of the two circuits. There will be a relative position giving a maximum mutual induction, and one giving a minimum, and since one position is obtained from the other by steady motion, the average value will be the arithmetic mean of the maximum and minimum values.

The winding coefficient is defined to be half the difference between the maximum and minimum values divided by the maximum value. This coefficient is less the larger the number of slots of the primary on the one hand, or of the secondary on the other.

If N is the mean value between the primary and secondary numbers per pole-pitch, then the winding coefficient is given approximately by—

$$\sigma_1 = 1 \cdot 3 \frac{K_1}{N^2},$$

where K_1 is always nearly unity.

Peripheral Dispersion.—In every motor there come into operation magnetic dispersions, or leakages, which we will separate into two stray fluxes. One of these, peripheral dispersion, runs along the face of the bore of the stator, and along the face of the cylindrical periphery of the rotor, since between the tops of the iron teeth of each single system over the openings of the slots there occurs a leakage of magnetic lines. These stray fluxes along the peripheral surface will bear to the mean total flux F the same proportion as the magnetic reluctance of the path followed by F bears to the magnetic reluctance which is interposed in the path of the stray magnetic flux between the tops of the teeth.

Denoting the quotient of the stray flux by the main flux by the coefficient σ_2, we obtain approximately—

$$\sigma_2 = \frac{K_2 \delta}{2 N \tau X} \text{ for open slots,}$$

and

$$\sigma_2^1 = \frac{5 K_2 \delta}{N \tau X} \text{ for closed slots.}$$

Where K_2 depends on the shape of the slots;

δ is the length of the air gap;

τ the length of the pole-pitch at the face;

N the number of slots in one pole-pitch;

and X is the width of the opening of the slot.

Flank Dispersion.—A second kind of magnetic dispersion which also occurs in every motor consists of a magnetic flux which exists outside the iron core. Those parts of the winding which constitute the end connections between conductors in the slots, and which project as curved winding bunches or bends at the flanks of the stator and rotor cylinders, give rise to a magnetic flux outside the iron core bodies. This flux surrounds these curved connections in such a manner generally that only a small fraction of the flux created by the bends of the one system intersects the bends of the other system.

In the main this stray flux is equal to the magnetic flux which would be created by an independent group of coils of a form similar to the two projecting bends at the two flanks, if put together as a coil. What is necessary is therefore to determine the self-induction coefficients of similarly constructed coils, and the coefficients of mutual induction between such coils if placed in such positions relatively to one another as would about correspond to the respective positions of the projecting bends in the stator and rotor.

The flank dispersion may be shown to be given by—

$$\sigma_3 = \frac{2 \cdot 5 \ K_3 \delta}{b},$$

where K_3 depends upon the winding arrangement

b is the axial length of the core

and δ is the length of the air-gap.

The total dispersion coefficient is given by

* See "Dynamo-Electric Machinery," by S. P. Thompson, page 629, 5th edition. Also "Polyphase Electric Currents," by S. P. Thompson, page 463, 2nd edition.

† Abstract of paper read by Dr. Hans Behn-Eschenburg before the Institution of Electrical Engineers, January 14th, 1904.

$$\sigma = 2\sigma_1 + 2\sigma_2 + 2\sigma_3$$
$$= 2\,6\,\frac{K_1}{N^2} + \frac{K_2\,\delta}{X\,N\,\tau} + \frac{5\,K_3\,\delta}{b}.$$

From experimental observations on several Oerlikon motors, the values of σ_1, σ_2 and σ_3 have been obtained, *e.g.*, in a motor in which the diameter of the bore is 150 cms. and the number of poles 16, and in which $\delta = 0{\cdot}15$ cm., $N_1 = 144$, $N_2 = 192$, with slots closed it was found by experiment that

$$\sigma = 0{\cdot}075,$$

and by calculation the value obtained is 0·088.

The dispersion coefficient may well form the basis upon which to design induction motors, as upon it depends the power factor.

LEGAL.

Knight *v.* The Isle of Wight Electric Light and Power Co.

In the Chancery Division of the High Court of Justice on Wednesday, January 20th, Mr. Justice Joyce delivered his reserved judgment in this case, which raised an important point as to the liability of electric, gas, and other public companies for nuisances caused by them in the construction and carrying on of their works. The judgment sets out the facts of the case.

Mr. Justice Joyce said that the plaintiff was the lessee for the residue of the term of 21 years from September, 1900, at a rent of £250, of a house, gardens, and grounds in the borough of Ryde, and was carrying on there a high-class school for young ladies. In 1899 the Corporation obtained a provisional order under the Electric Lighting Acts, authorising them, in the usual way, to supply electric energy for public and private purposes within the borough. Clause 69 of the provisional order provided that nothing in the order should exonerate the undertakers from any indictment, action, or other proceeding for nuisance in the event of any nuisance being caused or permitted by them. There was then an Act of Parliament confirming that order, and subsequently the Corporation entered into some arrangements with the defendants for the erection, maintenance, and working of a generating station within the borough. In pursuance of such arrangement, the defendants, in the early part of 1903, acquired, as a site for the purpose of the proposed works a piece of land adjoining the garden of the plaintiff's house. The engines were driven by gas produced on the premises by a system of the character known as the Dowson process. One of the terms under which the defendants held their site precluded them from erecting any tall chimney shaft thereon. The plaintiff's house was at a higher level than the defendants' generating station, and there were no intervening buildings. The formal opening of the works as completed, or supposed to be completed, took place with some kind of municipal ceremony on October 18th, 1903, and from that date, he supposed, if not before, the works had been supplying the energy for the production of electric light to customers. Of course, it was hoped by the defendant Corporation, and it was to be expected, that the demand for this supply would constantly and greatly increase, and that consequently from time to time additions and extensions would have to be made in the plant and machinery at present installed on the premises of the defendants. Before the formal opening of the works the manufacture of gas for working the engines and machinery generally had, of course, been in operation, and in particular on one occasion in the month of September for a period of nine hours, the engines and dynamo were working without any intermission. The plaintiff complained of serious annoyance to the inmates of her establishment by noise, vibration, and offensive smells produced by the operations at the defendants' works, and she instituted this action on September 29th, claiming an injunction and damages in respect of the alleged nuisance. The action was tried upon several days during the Michaelmas sittings, and a large body of evidence adduced before him. To his mind, the result of it had been that, having regard to the positive testimony of the plaintiff and the witnesses called on her behalf, whose veracity and substantial accuracy he saw no reason to doubt, and the facts admitted by some of the defendants' witnesses; having regard also to the correspondence and pleadings and arguments addressed to him by counsel for the defendants; he considered it to have been almost virtually admitted, and at all events to have been sufficiently proved before him, that at various times during the month of September, and for a not inconsiderable period afterwards, the works of the defendants were so carried on as by noise, offensive smell, and in some degree vibration, to occasion a serious interference with the ordinary comfort of the plaintiff and the inmates of her house, and the carrying on of her business. The annoyances were not in his opinion trivial, or of a kind to be expected from any ordinary and reasonable use of the land acquired by the defendants, nor were they by any means of such a kind as would be complained of only by unreasonable and fastidious persons. No doubt, it was the fact that, since the commencement of the action, the defendants had, by the adoption of various expedients known to mechanical engineers and men of science, and perhaps under the pressure of these proceedings, by measures of a special character greatly diminished the intensity and frequency of the annoyances complained of. The engines and machinery were not now working later than 11 p.m. There was, he thought, still room for further improvement at the cost of further expenditure, and the most skilful and careful management were necessary to prevent the nuisance complained of from constantly recurring. At times there was no annoyance to complain of. Still, at the date of the trial such an annoyance had repeatedly and constantly recurred. Even then the works were not in such perfect order, if such perfection were obtainable, as to remove altogether the plaintiff's just grounds of complaint. The engines did not do their work to the satisfaction of the defendants themselves, and the workmen of the firm which erected them had still to be in attendance. In his opinion the plaintiff had ample justification from the institution of this action; in other words he held that repeated, and not merely momentary, annoyances caused to the plaintiff did amount to an actionable nuisance, unless the defendants could make out they were in point of law justified in causing such an interference with the comfort of the plaintiff's premises. The defendants contended that they were to be so excused, and in support of that contention, they relied on a judgment of Lord Justice Vaughan-Williams in the case of Harrison *v.* the Southwark and Vauxhall Water Co. The passage relied on was this:—"In the first place it seems to me, if defendants had, without statutory authority, sunk the shaft and pump for any lawful or ordinary purpose in the exercise of their powers as private owners of the land, they would not have been responsible for a nuisance. It frequently happens that the owners or occupiers of land cause in the execution of lawful, and in the ordinary user of land, a considerable amount of temporary annoyance to their neighbours. But they are not necessarily on that account held to be guilty of causing an unlawful nuisance. The business of life could not be carried on if it were so. For instance, a man pulls down his house for the purpose of building a new one, causing considerable inconvenience to his next door neighbours during the process of demolition. But he is not responsible as for a nuisance if he uses all reasonable skill and care to avoid annoyance to his neighbour by the work of demolition. Nor is he liable to an action, even though the noise and dust, and the consequent annoyance, be such as would constitute a nuisance if the same, instead of being created for the purpose of the demolition of the house, had been created in sheer wantonness, or in the execution of works for a purpose involving a permanent continuance of the noise and dust. For the law, in judging what constitutes a nuisance, does take into consideration both the objects and the duration of that which is said to constitute a nuisance." Accepting that statement of the law, it must be observed that the annoyance or nuisance complained of in the present case did not arise from acts of the kind referred to in the passage he had read. The plaintiff had submitted to the inconvenience, if any, that arose from the mere construction of the defendants' works. What she complained of was what she had suffered, and was from time to time suffering, from the works of the generating station and the works there carried on, and would continue to be carried on. This he held not to be an ordinary user of the defendants' property, or in any sense reasonable, if serious annoyance were thereby occasioned to the occupiers of the adjoining house and gardens. Another excuse was that the annoyance was only temporary and occasional. He considered an answer to that had been supplied from the case which had been read by Mr. Hughes, it being borne in mind that what was being done here was not, in his opinion, an ordinary user of the defendants' land. The defendants did not allege, nor had it been shown, that their works could have been established and set permanently in operation without causing a nuisance if necessary and reasonable precautions had been taken in the first instance. He held that the acts complained of had from time to time, and frequently up to the trial, materially interfered with the ordinary and comfortable existence of the plaintiff in her house; and, secondly, that these acts were such that, having regard to the circumstances and surroundings of the defendants' property, they were in excess of the natural and ordinary use and enjoyment of her property. The consequence was there must be an injunction during the continuance of the plaintiff's lease, restraining the defendant company, their directors, servants and agents, from using or working, or causing or permitting to be used or worked, in or upon the generating station and their works adjacent to the plaintiff's gardens, any engines, dynamos or other machinery, and from so carrying on the manufacture of gas, or any other process as by the production of noise, obnoxious or offensive smells, vibration or otherwise, so as to cause a nuisance to the plaintiff as lessee of the house, gardens and premises, comprised in her lease.

His Lordship granted an inquiry as to damages, and reserved the cost of the inquiry. He also directed that the defendants should pay the costs of the action, and on the application of Mr. Younger, K.C., suspended the operation of the injunction for six weeks.

Watson *v.* the Mayor and Corporation of Sunderland.

In the King's Bench Division of the High Court of Justice on Thursday last week, before Mr. Justice Wills and Mr. Justice Kennedy, the defendants in this case appealed from a decision of the Judge of the Sunderland County Court, and raised a question of importance in regard to the liability of electric tramway owners for injuries caused by a falling wire. The plaintiff, Mrs. Watson, was travelling with her daughter on one of the electric tramcars belonging to the Sunderland Corporation, when, owing to a wire falling, she received it was said, an electric shock, and was personally injured. The evidence for the plaintiff went to show that the wire broke, and that in consequence the injuries were sustained, and at the conclusion of plaintiff's case counsel for the defendants submitted that there was no evidence of negligence on defendants' part to go to the jury. The

County Court Judge ruled, however, that there was a case to go to the jury, and evidence was then given for the defence to show that the whole system had been inspected by the Board of Trade, that there was a proper weekly inspection by the Corporation's employés, and that the breaking of the wire had not occurred through any negligence. The jury in the result found there was negligence, and gave a verdict for the plaintiff, with £25 damages.

Mr. C. A. Russell, K.C., and Mr. K. Simey appeared for the appellants, while the respondent was represented by Mr. W. G. Clay.

Mr. Russell argued that the County Court Judge ought not to have allowed the case to go to the jury, and that, even if there was a case to be submitted to them, the evidence for the defence rebutted any suggestion of negligence, and verdict ought to have been directed and evidence entered for the defendants. He also criticised the summing up of the learned judge, on the ground that it did not tell the jury specifically what it was in respect of which it could be said the Corporation had failed in their duty.

Mr. Clay contended that the plaintiff having made out a *primâ facie* case, no such evidence was given in refutal as would make it the duty of the County Court Judge to practically direct a verdict for the defendants. It was for the defendants to show how the accident occurred, but the explanations they gave, such as they were, left the cause of the accident a mystery. Under the circumstances, the jury were entitled to come to the conclusion that the wire fell because of defective joining.

Mr. Justice Wills said he was of opinion that this appeal must be dismissed. It was a case in which an accident happened as to which one might, in popular language, say that if everything had been right it had no business to have happened. These overhead wires were not expected to tumble down of themselves, and if there was to be a liability to that kind of accident, Parliament would be very slow to grant the powers which they had granted, therefore it seemed to him it was a case in which, from the accident, if nothing else occurred, a very reasonable conclusion would be that there must have been something wrong in the construction of the wire or in the way in which it was joined, or that there was some mismanagement of it in some way or another. Therefore it was quite clear that there was a case to go to the jury. What happened before the case was finally left to the jury was that the defendants were wholly unable to suggest any explanation of how the accident happened. Under these circumstances, they satisfied the tribunal not merely that they were unable to explain it, but that such an accident could happen without there being any explanation at all; the jury were justified in saying that no explanation was no explanation, that, for some reason or another, they could not get at the bottom of it, and they thought the fact that the accident happened was quite inconsistent with due care having been exercised all round and all through, and therefore they found that there had been negligence on the part of the defendants which had caused the accident. The summing up of the learned judge was fair and impartial, and the course he took could not reasonably be complained of.

Mr. Justice Kennedy concurred, and the appeal was dismissed with costs, leave to appeal further being refused.

British Accumulator Co., Ltd., and Another *v.* Kramer.

In the Chancery Division of the High Court of Justice on Friday last, Mr. Justice Kekewich had before him a motion by the British Accumulator Co., Ltd., and the Allgemeine Accumulatorenwerke Aktien-Gesellschaft to restrain Arnold Kramer from carrying on business of any description under the style or title of the British Accumulator Co., Ltd., and from receiving and opening any letters addressed to that company. It also sought to restrain him from acting as manager and agent of the company, and claimed delivery up of the furniture, books and other effects in the office at Victoria Street, Westminster.

Mr. Warrington, K.C., who appeared in support of the motion, stated that the German company carried on the manufacture and sale of electric accumulators at Vienna. In 1902 they were minded to establish a branch of their business in London, and for that purpose they employed the defendant as their manager. The agreement set forth that the defendant undertook the management of the agency in London for the sale of accumulator batteries. Besides a salary, he was to receive 10 per cent. of the net profits of the London agency. The contract, it was further stated, could not be cancelled during the term of 18 months from the date on which it was signed. For the purposes of the branch business, defendant took offices in Parliament Street, Westminster, the rent and furniture being paid by the plaintiff company. From the first it seemed to have been contemplated that eventually the British business would be turned into a limited company under the Act of 1862. In 1903 the British Accumulator Co., Ltd., was incorporated, and a verbal agreement was made that the business and all the assets of the British Accumulator Co. should be tranferred to the limited concern. The defendant refused to hand over the books and the other assets, and on December 19th, 1903, a letter was written to him by plaintiffs' solicitors stating that they had been instructed to take all steps necessary to obtain a transfer of the effects of the company. Defendant called himself chief engineer and manager of the company, although he had been appointed to no position by the limited company. On December 21st, 1903, the defendant wrote to the Vienna company stating that they had been breaking the terms of the contract time after time, and that he considered it necessary to inform them that he regarded it as having come to an end. Defendant then made certain claims for compensation. Counsel, proceeding, read an affidavit by James Wilson, Wandsworth, in which it was stated that, in December, 1903, he entered into a contract with the defendant, on behalf of the British Accumulator Co. for the erection of electric plant at Rickmansworth. A cheque for £50, in part payment of the account, was given by him to defendant. Letters which he received from defendant were headed "British Accumulator Co.," and were signed "A. Kramer, managing director."

Mr. Stewart Smith, K.C., for the defendant, read a long affidavit in which Mr. Kramer set forth that the offices were taken in his name, as the landlord was not willing to let them to a foreign company. Defendant was, therefore, personally liable for the rent. He had never represented the business as his own, and had always been willing to transfer the office and furniture to the plaintiff company, provided that company paid the rent due to the landlord and freed him from all personal liability. He had received accounts on behalf of the plaintiff company, but there was a considerable balance due by the plaintiff company to him. The learned counsel, in the course of further remarks, stated that there was a substantial counterclaim by defendant for wrongful dismissal.

After some discussion, it was agreed that the plaintiffs should give an undertaking to pay the rent due, and that defendant should deliver to plaintiffs all furniture, fixtures, plant, books, contracts, papers, and other effects in the office in Parliament Mansions, Victoria Street. Further, that on sufficient indemnity being given by plaintiffs against a covenant contained in the agreement of tenancy, the defendant should deliver up possession of the premises to the plaintiff company.

His Lordship said the costs of the motion would be costs in the action.

Skipworth *v.* National Electric Traction Co., Ltd.

In the King's Bench Division of the High Court of Justice on Saturday, before Mr. Justice Grantham, this case was mentioned. Mr. Wootten, for the plaintiff, said it was an action for the return of £198 paid by the plaintiff to the defendant company for certain shares in the City and Surrey Electric Railway Co., which they advertised in July, 1902. Those shares had never been delivered. An affidavit was put in under Order XIV., in which it was asserted that other shares had been given in lieu thereof, but that was not accurate.

Defendants did not appear, and counsel simply proceeded to put his client into the box.

Mr. Skipworth, the plaintiff, said that in July, 1902, he paid £200 for his shares, but they had never been delivered, and he had never received any shares in lieu thereof. He had received £1 8s. 6d., and now claimed the balance.

Judgment for the amount claimed was given with costs.

Simplex Steel Conduit Co., Ltd., *v.* Metallic Seamless Tube Co., Ltd.

This action came before Mr. Justice Swinfen Eady in the Chancery Division on Saturday, Mr. Sebastian for the plaintiffs moving for judgment on admissions by the defendants. The plaintiff company, he said, was incorporated in 1898 for the purpose of manufacturing and selling steel conduits and fittings and materials for electric cables. Their goods were very well known by the name Simplex. The defendants admitted that certain of their agents had supplied goods not of the plaintiffs' manufacture under orders for Simplex goods.

His Lordship gave judgment for the plaintiffs for an injunction.

Woodhead *v.* Briggs.

At Ashton-under-Lyne County Court, on January 21st, Judge Brown, K.C., heard a case in which Mr. J. Woodhead, electrical engineer, sued Messrs. Briggs Bros., clothiers, for £68, due in respect of the wiring of premises for the electric light. The defence was that the installation was defective, and Mr. Anthony Wilson, surveyor for the County Fire Office, deposed that a lot of the wiring was not in wood casing, which was enough for any insurance office to decline to insure. Judgment was given for plaintiffs for £36 19s. 1d.

Geipel's Steam Traps.

In the Court of Appeal, composed of Lords Justices Vaughan-Williams, Stirling and Cozens-Hardy, on Monday, the hearing was concluded of an appeal from an order of Mr. Justice Buckley on a petition for revocation of Geipel's patent for steam traps, and there was also a cross appeal by the patentee on the question of the terms on which he shall be allowed to disclaim, his Lordship having found that the patent was invalid in certain particulars.

Mr. Justice Buckley held that the patent was bad in two respects:—First, that one of the figures attached to the specification in which the pipes were bent into a circle showed an arrangement that would not work; and secondly, that a modification of the device shown in another figure, in which the triangular form was adhered to, but one of the legs was the tie-rod instead of a tube, was not within the provisional specification. The inventor accepted the first part of the decision, but challenged the second, and asked that it might be reversed.

For the petitioner, Mr. C. H. Berry, of Manchester, it was submitted that at the date of the patent, there were hundreds of steam traps on the market, and several that depended upon the expansion and contraction of metal by the action of steam. The respondent appealed against the part of the order, which imposed as a condition, on which the patentee should be allowed to apply to the Comptroller for the amendment of his claim, that he should not

ask for an injunction founded upon anything done prior to the date of the amendment unless the Court in trying the subsequent action, was of opinion that the specification was framed originally in good faith, and with reasonable skill and knowledge. For the petitioners it was said that they had been making these traps for years. They brought this action to protect their customers, and it was only reasonable for the Court to say that no action should be brought in respect of traps made before the judgment.

Their Lordships dismissed the respondent's cross appeal, and reserved judgment on the remainder of the case.

BRITISH ELECTRIC CAR CO.; SINCLAIR *v.* THE COMPANY.

IN the Chancery Division of the High Court of Justice on Tuesday, this case came before Mr. Justice Kekewich on a motion for judgment. Counsel stated that the action was by a debenture-holder. Mr. Justice Joyce had appointed a receiver and manager. There were a number of contracts which had to be carried out.

HIS LORDSHIP made the usual order for accounts and inquiry in a debenture-holder's action, and continued the manager's appointment until July 31st.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

The Bristol Fire and Its Lessons.

A few years ago it was the proud boast of many central station engineers that it was quite unnecessary to insure electricity works, and that there was absolutely nothing in them to burn. Recent events, however, point to the fact that this idea is a fallacy. During the last two years the writer remembers four serious fires which have taken place in electricity works, viz., Islington, Croydon, Bristol, and only last week, Salford.

In the first two instances the fire broke out, so far as is known, in the cable trenches leading to and from the main switchboard; Bristol fire was due to faulty fuses, while at Salford the fire seems to have arisen in the cable trench.

In view of these facts, would it not be wise for central station engineers to overhaul their cable trenches, &c., inside the works?

I would suggest that all unprotected cables, having such inflammable insulation as rubber or bitumen, should be replaced by some type of cable having a non-inflammable covering, which I believe can now be obtained. Further, where local circumstances permit, each cable should be enclosed in a separate stoneware duct direct from the switchboard to each generator, or to a point outside in the case of feeder cables. As a further precaution the cables might be packed in each duct with sand or loamy material to prevent fire creeping along. Even lead-covered cables should be protected in a similar manner, as should a fire occur from some extraneous cause, the lead covering might be melted before the fire was discovered, and the highly inflammable paper or other insulation ignited.

There is no doubt that if some precaution similar to the above was adopted, even should a fire occur the cables themselves would not be seriously injured; in the case of Bristol it appears that the great delay in restoring the service was owing to the cables within the generating station being destroyed, and had this not been the case, no doubt the delay in resuming supply would have been very much less, as the cables could have been quickly connected in a temporary manner.

The writer knows of several electricity works where the cables leading to the switchboards are in very dangerous positions, being surrounded by woodwork and leading to switchboards on *wooden* floors above. There is no doubt that if a fire occurred in any of these works, very serious results would follow.

Matters such as these, easily remediable, should be put in order at once; for if many more fires such as those mentioned occur, the public will, not unnaturally, lose all faith in the reliability of electricity supply.

Wm. J. U. Sowter.

Dorchester, *January 23rd*, 1904.

The Municipal Appointment at Leicester.

I read in your issue of this week the remarks of "Disgusted" in reference to the above, and heartily agree with him. I made application for the position, and having occasion to go to Leicester, met an acquaintance, and mentioned the fact of having made application. He smiled, and said: "It is no use your trying to get the position; it will be given to a Leicester man who has been on the slate for some time." In making application for a position, one naturally thinks that if he shows himself to be the best man he should have it; and it is certainly very discouraging to wait for, perhaps, three or four weeks, and then receive notice that the vacancy is filled, no word having come in the meantime to let you know that your application had even been looked at.

Another of 'Em.

Explosion of Enclosed Arc Lamps.

In connection with the letter in your last issue under this heading, we should like to point out that, although this danger exists in all enclosed arc lamps, it has been guarded against from the first in those of our make. In the single enclosed lamps the globe is held up firmly by means of a spiral spring, but the gas can explode quite harmlessly, a little chattering of the globe against the top ring being the only result.

In our double enclosed lamps the top plate rests quite lightly on the inner glass and lifts directly against any excess pressure.

The explosion in the outer globe described by your correspondent is, however, quite outside our experience, and the inner glass being uninjured makes it all the more mysterious. Possibly the breakage in this case was due to some external cause.

The Westminster Engineering Co., Ltd.,
J. O. GIRDLESTONE.

Willesden Junction,
January 25th, 1904.

After an enclosed lamp is switched off, the air leaks into the globe and mixes with the carbon monoxide, making carbon dioxide. The latter gas is explosive, and if sufficient is left in the globe when the lamp is re-switched on, it will explode. The inner globe is usually kept in place by a spring, which acts as a safety valve when necessary.

These explosions, however, are always liable to break the globe, and it is better to avoid them if possible. They will not take place if the air can leak into the globe quick enough to allow the red hot carbons to ignite and burn away the CO as it changes to CO_2; but on the other hand, the burning time of the lamp is decreased with the greater amount of air which is allowed to enter the globe while the lamp is burning.

I have recently patented the use of a valve which is closed while the lamp is burning, but which automatically opens and allows the air to enter the globe when the lamp is switched off. The vacuum can be the best possible by this arrangement, and the fullest burning time be obtained, the risk of an explosion being entirely eliminated.

Herbert E. Angold.

Maxim Works,
Gillingham Street, W.C.
January 25th, 1904.

[Our correspondent's chemistry appears to be a trifle unorthodox. Air and carbon monoxide do not make carbon dioxide by simple mixture, nor is CO_2 explosive!—EDS. E.R.]

A "Canadian's" Complaint.

The English manufacturer has many faults, but I think the trouble "Canadian" finds is not due so much to the manufacturer as to his own lack of knowledge of this particular branch of the English trade. There are several firms of reputation in England who make a speciality of "specials." (See advertisements.)

Gent & Co.

January 25th, 1904.

["Canadian's" letter brought many other communications from correspondents anxious to show that British manufacturers are not quite so black as he painted them.—EDS. E.R.]

Reverse Current Cut-outs for Alternating Circuits.

It has been stated by several contributors to your columns lately that reliable reverse current cut-outs for alternating circuits are not to be obtained. I would point out that such cut-outs (*i.e.*, relays) constructed on the wattmeter principle are quite correct in theory. These come into action directly a certain predetermined *power* flows in the reverse direction. In practice this power is greater than that exchanged between generators when paralleling; thus the relays do not require to be put out of action during this operation. Relays on this principle are now on the market, and there is no reason to suppose that they will give other but perfectly satisfactory results in practical working.

I might add that the above principle is the only one on which a reverse current, or, properly speaking, reverse power, cut-out for alternating currents, can be constructed.

Charles C. Garrard.

Manchester, *January 23rd*, 1904.

Electricity in India.

With reference to the letter which appeared in our November 27th issue, signed "X. Y. Z.," we have received the following reply from our correspondent who wrote the original article which "X. Y. Z." desired to correct:—

I note your correspondent's letter on page 854 of your November 27th issue. The regulations which formed the basis of my communication are accurate in every respect. I considered it most desirable that English manufacturers and your readers generally should be informed of them at the earliest possible date. The Indian Electricity Act (III. of 1903) was passed early in the year, the working rules under its regulation were promulgated on September 15th, 1903, a few days prior to my article. Since that publication all the installations, or projected installations, have been designed in accordance with their provisions, which became operative on January 1st, 1904.

Your Correspondent.

The Education of an Electrical Engineer.

One cannot help admiring the remarks made by Mr. Smith in your last week's issue. I always thought that station engineers were badly paid, but when it comes to advertising for a man to give instruction in the design of modern alternating-current machinery at a salary of £150 per annum, it is time something was said. If this state of affairs is going to continue, I would strongly advise all engineering students to seek their tuition either in America or Germany.

E. A.

Whilst agreeing with your correspondent, Mr. S. H. Smith, that the salaries of technical instructors in this country are deplorably inadequate, I fail to see why he should make his unjust and pointless comparison between the two advertisements mentioned.

A perusal of his letter gives one the impression that the relative qualifications of the correspondence instructor and the City and Guilds lecturer are as those of a pupil-teacher and a public school headmaster—at any rate, that he thinks so. Is not electrical engineering the same, whether taught by correspondence or otherwise?

Mr. Smith is evidently ignorant of the importance attached to instruction by post nowadays.

If he cares to look up what members there are on the staff of the University Correspondence College, for instance, I think he will find that they compare favourably with those of any other college staff.

Arrowroot.

With reference to the lowness of the salaries offered to teachers in our technical institutions, I should like to draw your attention to an advertisement now appearing in the engineering papers. The one I refer to hails from the Finsbury Technical College, of all places, which requires an assistant instructor in mechanical drawing at the inadequate salary of £70 a year. What the *practical experience* in the shops or drawing office of the successful candidate would be it would be interesting to know, and also his wages under his last employer. I fancy some of his day students will know more than *he* can teach them.

Demonstrator.

The Wolverhampton Tramways.

Being interested, naturally, in the efforts to better the systems of quick transit and general safety of the public in our large towns, I am surprised to see the one-sided manner in which this paper always discusses anything appertaining to the Wolverhampton tramways.

There is not the least doubt that the system that town has adopted takes a little more current than the overhead trolley system, but we cannot expect *perfection* in two or three years. Take the difference between 6·68d. and 7·28d.—·60d. working expenses per car-mile of the East Ham and Wolverhampton systems, and compare what we get for this difference.

None of the columns to obstruct our paths and roads, safety from fallen wires, no din of the trolley in our ears, and more seating capacity on the top of cars.

Having travelled on most of the systems that are recognised as *the examples*, and on *poor* Wolverhampton, I will say that that of the latter town surpassed any of the former for comfort and safety, and the corporation is not a limited company but works for (or ought to do) the bettering of the condition of its citizens, and so long as it keeps its affairs in paying order and carries out the above, then its duty is being done.

Again, in reference to the comparison of figures, Wolverhampton has a very heavy run, and that pulls the average up a bit, and after the contacts have been renewed they will get less leakage current to deal with.

Has not Wolverhampton as much right to increase its expenses by the conveniences mentioned above as East Ham has by charging fares that will not pay?

Norman Hope.

[Our correspondent has not carefully studied our article; the actual difference in cost per car-mile is at least ·89d, and would be greater for a full year's working. Moreover, the East Ham traffic is much the greater. As for fallen trolley wires, what about live studs?—EDS. E.R.]

Electricity in Mines.

I was very pleased to see the article in your journal on "Electricity in Mines." As electrical engineer to a large colliery company in the Midlands, I should like to say a little on the use of electricity for coal cutting.

My firm has tried almost all makes of machines for "heading" and "longwall," but I cannot speak as favourably of them as Mr. Tonge does in his article last week. We have a "Jeffrey" heading machine, which is practically on the scrap heap, for we cannot work it successfully in any of our pits. We tried it cutting in bat and coal in a 4-ft. seam, and found it would list either to port or starboard sooner than head in the coal, and in the time it took in timbering, &c., a collier could hole the amount it would cut and cost no more.

Next we tried the Diamond longwall disc machines in the same pit, and we could not work these because we could not keep the cutter wheel from rising up the face. We had the Diamond experts to see what they could do with it, but they had to give in. We tried the 6-ft. wheel and 4 ft. 6 in., each with the same result. We have had to take them out, and since then we have had all the coal-cutting machine makers' experts in the country to examine the seam, but none will guarantee their machine to cut on the floor.

We put the same machines in another pit with a 3 ft. 6 in. seam composed of hard and soft coal, the hard coal being divided from the soft by a layer of bat, into which the machine cuts, I am pleased to say, with better results; we use in this case a 6-ft. wheel.

The Diamond machines might have been designed by a man who never saw a colliery, for to remove the armature takes about a day; I know from experience that it took two fitters seven hours to get off the bevel wheel of the armature shaft, which is a tight drive on and has to be wedged off, this process damaging the shaft and bearing a great deal.

The carcase or frame of the motor is cast in one piece, therefore the armature has to be pulled out from the front end of the motor, this doing not a little damage to the armature, sliding it out on the pole-pieces, as only one man can get at it to lift it; then again, the connection between the two field coils is made inside, and when the armature is in it cannot be seen, and at the same time there is not sufficient space between the armature and the carcase to allow much insulation, hence this proves a source of trouble, and causes much time to be lost, for if anything happens to this connection, which very often does, the motor has to be taken to pieces to get to it, whereas if the motor had been made in two halves, it would not cause half the trouble or delay.

There is a splendid field for electricity in mines if our manufacturers care to go into the matter, and make machinery to suit the working conditions, both for coal-cutting and haulage, as we have a deadly rival in compressed air, which most mining engineers seem to favour, because the driving machinery is less complicated, much easier to get at at the coal face, and faults are sooner localised. I should be pleased to furnish any further particulars concerning the working conditions of the mines in question.

L. E. Wood.

[We have received a lengthy communication from a correspondent, headed "Switchboard Attendant *v.* Engine Driver"; the writer draws attention to the great discrepancies between the responsibilities and wages attached to these two classes of central station employé. He estimates that the former is paid on the average 60 per cent. less salary than the latter, and suggests that an organised attempt should be made to better the prospects of the switchboard attendant.—EDS. E.R.]

[INSULATING VARNISH.—A correspondent wants to know whether "Insuline," an insulating varnish for putting on armature core-plates instead of paper, can be bought in the open market. Can any reader help him?

ECLIPSE METERS.—We have mislaid the address of "Supply." For these meters, communicate with Mr. G. Braulik, of Upper Thames Street, E.C.—EDS. E.R.]

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JAN. 20TH, 1903.	
Alexandria	Value £16
Amsterdam	234
Antwerp	225
Auckland	224
Bombay	156
Calcutta	201
,, Teleg. wire	52
Cape Town	775
,, Teleg. mat. ..	3,420
,, Elec. lgt. stm. eng.	1,982
Christchurch	16
Durban	665
,, Teleg. mat.	2,681
East London	855
Gibraltar	156
Halifax	25
Hamburg	200
,, Teleg. mat. ..	100
Hiogo	79
Hobart	64
Hong Kong. Teleg. cable ..	400
Lisbon	27
Melbourne	115
New York	15
Otago	54
Perth	28
Port Elizabeth	72
Shanghai	6
Singapore	36
Sydney	656
Vera Cruz	191
Wellington	278
Yokohama	860
Yokosuka	120
Total ..	£14,479

WEEK ENDING JAN. 19TH, 1904.	
Adelaide	Value £56
Alexandria	30
Amsterdam	125
Antwerp	234
Auckland	120
Bombay	125
,, Teleg. mat.	953
Calcutta	981
,, Teleg. mat.	61
Cape Town	316
Colombo	70
Durban	1,160
,, Teleg. mat.	260
East London	70
,, Teleg. mat. ..	67
Hong Kong	16
Melbourne	62
,, Teleg. mat. ..	75
,, Telephones ..	78
Monte Video	108
N. Atlantic. Sub. teleg. cable	14,300
Oporto	78
Otago	42
Perth	27
,, Elec. cable	208
Reval	55
Rio Janeiro	25
St. Petersburg	55
Santos	196
Shanghai	107
Singapore	20
Stockholm. Teleg. wire ..	222
Sydney	491
Wellington	1,994
,, Teleg. mat. ..	1,840
Yokohama	246
Total ..	£24,873

Foreign Goods Transhipped.

Bombay.	Elec. mat. ..	Value £97

Electrical Wares Exported.

WEEK ENDING JAN. 27TH, 1903.	
Alexandria	Value £16
Amsterdam	234
Auckland	252
Calcutta	301
Cape Town. Teleg. mat. ..	1,102
Colombo. Teleg. wire	596
Copenhagen. Teleg. wire ..	54
Durban	766
,, Teleg. mat.	5,229
East London	785
Gibraltar	168
,, Teleg. mat.	21
Hamburg	299
,, Teleg. mat.	100
Hiogo	79
Hobart	64
Mahe	30
New York	15
North Atlantic. Teleg. cables	20,000
Perth	68
Port Elizabeth	171
Rio Grande do Sul	70
Sydney	204
Vera Cruz	191
Wellington	280
Total ..	£30,945

WEEK ENDING JAN. 26TH, 1904.	
Amsterdam	Value £35
Auckland	194
Batavia	30
Bombay	50
Buenos Ayres	334
Calcutta	1,458
Cape Town	24
Chefoo	36
Coronel	35
Durban	700
,, Teleg. mat.	40
,, Teleg. plant.	616
East London	295
Fremantle	68
Hamburg. Teleg. mat.	155
Kobe	70
Lisbon	66
,, Teleph. mat.	191
Madras	22
Mauritius	39
Ostend	20
,, Elec. instruments ..	100
Perth	257
Port Elizabeth	54
Rotterdam	180
Saigon	3
Seychelles. Teleg. mat ..	41
Shanghai	220
,, Teleg. wire	256
Singapore. Teleg. mat.	30
Sydney	431
,, Teleg. cable	1,222
Wellington	72
,, Teleg. mat.	215
Yokohama. Teleg. apparatus ..	110
,, Teleg. wire ..	880
Total ..	£8,449

Bankruptcy Proceedings.—At a sitting of the London Bankruptcy Court, held on Friday before Mr. Registrar Brougham, the public examination was held of George Neale, electrician, lately trading as The South-Western Electrical Contracting and Maintenance Co., at 802, Fulham Road, and 2, Palace Terrace, Fulham. The statement of affairs shows total liabilities £1,099, of which £375 is expected to rank against assets valued at £209. Under examination by Mr. G. W. Chapman, the Official Receiver, the debtor stated that after being for some years employed as an electrician, he in August, 1900, with £50 borrowed capital, commenced business as an electrical contractor, and traded as "Neale & Croft," at 9, Pepys Road, Wimbledon. In August, 1901, he was joined in partnership by another person, and the business was carried on by them at 802, Fulham Road, until January, 1902, when the partner retired, and witness continued the business alone under the style of "The South-Western Electrical Contracting and Maintenance Co." In September, 1902, he was joined by another partner, who brought in £500 capital and paid £250 premium, the latter amount being put into the business by witness as capital. They then removed to adjacent and larger premises at 2, Palace Terrace, and after expending £200 thereupon, they traded under the same style down to August 1st, 1903, when the business, together with the liabilities, was taken over by a limited company. As joint vendor witness received £50 in cash and £850 in shares, all of which, with the exception of 10, he had disposed of. He had since acted as managing director of the company, at a salary of £200 per annum. Early in 1903 witness and his partner made arrangements to start a separate motor-car business, under the style of the "South-Western Motor Co." with the view of eventually selling it to the before-mentioned limited company. Sheds were constructed at the rear of 2, Palace Terrace, at a cost of about £100, but beyond purchasing and repairing certain cars, &c., practically nothing was done. Witness ascribed his position to loss in connection with the motor-car business through the action of his late partner. The examination was ordered to be concluded. Appended is a list of the principal creditors, viz.:—

UNSECURED.

Jones, E. W., Brentford	£205
Kishan, T. M., 76, Cornhill, E.C.	140
Savory, Pryor & Blagdon, 222, Strand, W.C.	24

FULLY SECURED.

South-Western Electrical Co., Ltd., Fulham	£200

CONTINGENT LIABILITIES.

British Electrical Co., London	£40
Terminus Electrical Supply Co., London	411
Gardner, S. R., Burton Court, S.W.	68

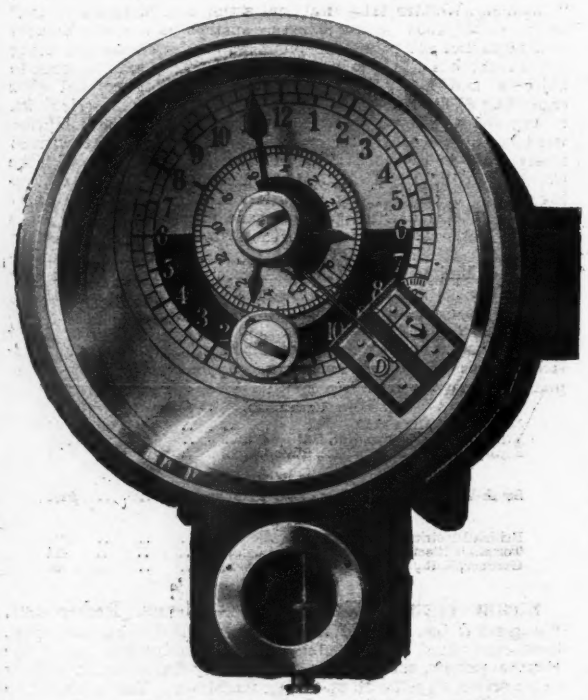
Steam Turbine Manufacture.—Messrs. Richardsons, Westgarth & Co., Ltd., of Hartlepool Engine Works, Hartlepool, have commenced the manufacture of steam turbines under the Parsons patents, and for this purpose they have erected entirely new works equipped with up-to-date machinery. The turbine to be built at Hartlepool will embody the modifications and refinements so successfully introduced by Messrs. Brown, Boveri & Co., of Baden. It is of interest to note that Messrs. Brown, Boveri have constructed, or have in course of construction, turbines of about 150,000 H.P., including one unit of 10,000 H.P. for Essen, and 35,000 H.P. in units of 8,000 to 9,000 H.P. for the Paris Metropolitan Railway, whilst the 5,000-H.P. turbo-alternators at Frankfort and Milan have been working economically for more than a year. Messrs. Richardsons, Westgarth & Co., it will be remembered, have for some time been representing the Baden firm in this country for all their electrical machinery. The plants manufactured at Hartlepool will be known as the "R.B.B." turbo-dynamos.

A financial contemporary says that Denny Bros. & Co., Ltd., shipbuilders, of Dumbarton, have secured a license from the Hon. Charles Parsons to manufacture turbines, and that plant will be laid down for the purpose without delay.

New Cars for Tyneside Tramways.—The Tyneside Tramways and Tramroads, Ltd., have placed with the British Westinghouse Co. an order for the equipment of six electric tramcars. This contract includes the trucks (Brill 21E) for four single-truck cars, and likewise for Brill No. 27 G bogie trucks, 4-ft. wheel base, for two cars. The double-truck cars will have four-motor equipments, with motors of the Westinghouse 80 pattern, No. 412 controllers, and the single-truck cars two-motor equipments, with motors of the 80 pattern, No. 210 controllers. The order also includes Westinghouse magnetic brakes for all cars, and heater equipments to be used in connection with the brakes.

Blaensychan Colliery Installation.—Messrs. Partridge & Jones, proprietors of the Blaensychan Colliery, near Pontypool, Wales, have recently given an order to the British Westinghouse Co. for a 112-KW. direct current generator driven by a Belliss and Morcom engine exhausting into a Körting ejector condenser. A three-panel marble switchboard will serve to control generator, motors, &c. The main purpose of the generator will be to supply power to a 100-H.P. Westinghouse motor, coupled to a Markham haulage gear.

Double-Tariff Meter Apparatus.—The supply of electrical energy for lighting and power purposes has, owing to the special conditions surrounding its generation, been the subject of various methods of charging at variable rates; amongst other well-known systems, that of charging at different rates for supply given during the daytime, and during the evening respectively, has long received special attention. A new apparatus for this purpose is being introduced at the present moment by the Electrical Co., Ltd., of Charing Cross Road. The apparatus consists essentially of a contact clock, or contactor as it is called, consisting of a well-made pendulum clock, which runs for one month with one winding; on the arbor to which the hour hands are attached, two cams are mounted controlling two contact springs, which, according to the setting of the cams, "make" and "break" the shunt (pressure) circuit of two watt-hour meters, any make of watt-hour meter being used in connection with this contactor. The method of charging is to charge the maximum price for energy consumed during the peak period, and to charge a minimum price for all energy consumed outside the peak period. The necessary apparatus consists of two watt-hour meters, and the contactor clock above-mentioned, through which the shunt circuits of the meters are taken: one meter registers the units consumed during the peak period, and the other meter the units consumed outside the peak period. Alternatively, one meter called the standard meter, can be arranged to record the total energy used, whilst the second or rebate meter, records the units used during any particular period. The Electrical Co. is also putting on the market a complete apparatus, consisting of a standard watt-hour meter, a rebate meter, and a contactor, mounted on a slate or wooden base and already inter-connected, which has the advantage of coming out considerably cheaper than two separate meters and a contactor. Owing to the method of construction adopted, all the contacts on the contactor are on the front of the clock and under observation, there being no contacts hidden behind the face. This is a valuable feature, inasmuch as periodical inspections can be made quite easily and without in any way breaking seals or opening cases. The whole apparatus is put up in a dust-tight case, an ingenious arrangement making it possible to wind up and reset the apparatus without in any way disturbing the dust-tight sealing. The apparatus is of thorough mechanical construction throughout, and is calculated to work for long periods of time without attention. Engineers and others interested in the matter should apply to the Meter Department, Electrical Co., 122, Charing Cross Road, for full particulars relating to the apparatus, and prices thereof.



DOUBLE-TARIFF METER APPARATUS.

Belliss Engine Contracts.—Contracts have lately been placed as follows:—

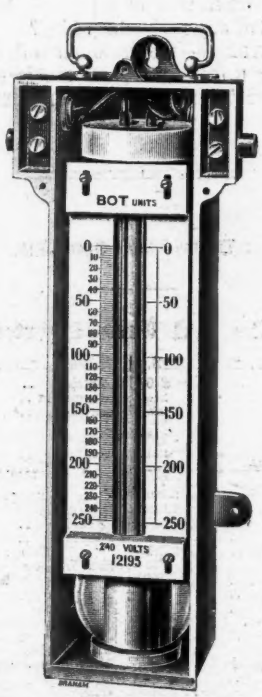
Kingston-on-Thames, by Siemens Bros. & Co., Ltd., for one 300-H.P. Belliss engine, coupled direct to Siemens alternator.

Pembroke Dockyard, by Siemens Bros. & Co., Ltd., two 1280-H.P. Belliss engines, coupled to Siemens 250-KW. generators.

Devonport, Tasmania, by the Brush Electrical Co., one Belliss engine for coupling to Brush dynamo.

Motor-Driven Machinery at the Bank.—The Bank of England have for some time past been experimenting with a few electric motors for driving their printing machines, and we learn that they are now engaged making a complete change to electric driving for all printing and other machinery on the Bank premises, including the deep well pump. The work is being carried out under the supervision of Mr. B. M. Drake. As will be seen from our advertisement pages to-day, the Bank is now offering for sale various small boilers, steam and gas engines, dynamos and batteries, which are no longer required, now that the above step forward has been taken.

Bastian Electrolytic Meters.—The original Bastian meter was made after the style of the well-known voltameter of the lecture room, *i.e.*, with platinum electrodes in acidulated water; the main objection to this construction was the great cost of platinum, which limited the area of the electrodes and thus prevented the voltage drop from being reduced to the minimum. In the new type, which is illustrated herewith (type "N") the electrodes are of nickel, with a very large surface, in an alkaline electrolyte, which has no chemical action on the electrodes. Also the connections with the electrodes are made on a new and much better system, and improvements have been made in the mechanical design of the meter. Every meter is now guaranteed to remain accurate within 2 per cent. and in good working order for three years, while they are unaffected by short-circuits, 100 per cent. overload for any length of time, vibration, dust, damp, &c., having no mechanism to get out of order. The starting current is, of course, infinitesimal. We have seen the scales in process of calibration at the Bastian Meter Co.'s Works, Kentish Town, N.W.; every scale is separately divided to correspond with the bore of the tube containing the electrolyte, and the calibration once made is permanent. The scale reads direct in units at the voltage specified. This type of meter lends itself admirably to installation on tramcars, as the vibration and rough treatment necessarily incurred have no effect upon it; it has, in fact, been successfully adapted to this purpose, being fixed in a special cast-iron case, which is bolted to the roof of the car. Its simplicity of construction enables it to be sold at a price which makes it feasible for the traction engineer to place one on each of his cars, instead of merely putting them on for trial runs, &c., as heretofore, and thus enable a real check to be placed on drivers, and if desired, the introduction of a bonus system.



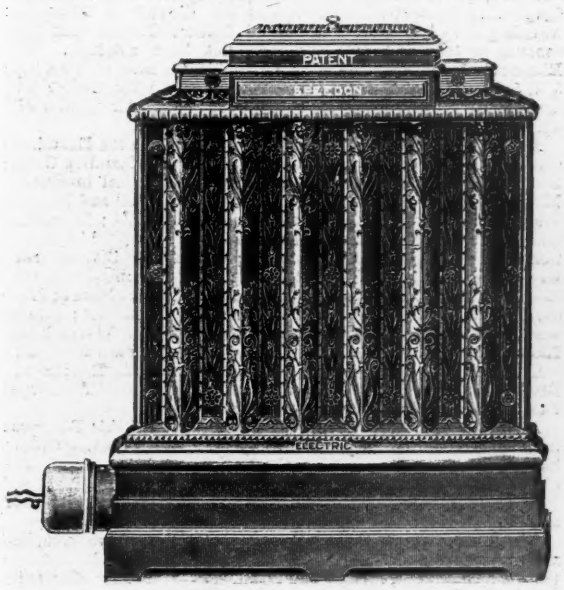
BASTIAN ELECTROLYTIC METER.

Carbon Brushes.—The Crypto Works Co., Ltd., of Clerkenwell Road, E.C., are placing on the market a new carbon copper brush, which is composed of copper very finely divided, mixed with pure graphite, which very materially decreases the resistance, and, at the same time, reduces the wear on the commutator. They have for a considerable time been using these brushes on their own machines, and have found the efficiency of the machines to improve whilst the commutation has not suffered. Circulars relating to it can be obtained on application.

Football; Gas v. Electricity. — We are pleased to learn that, in spite of gas at 1s. 11d. per thousand, the Bury Electricity Department can hold its own. A football match was played last Saturday between the staff of that department and the Gas Works, with the result of a victory for Electricity—10 goals to 2.

Reavell Compressors for Electricity Works.—There is a continued demand for the small duplex compressors which Messrs. Reavell manufacture for work in electricity stations, and among the latest orders may be mentioned a machine for the Dublin tramways, a second machine for the Cardiff Corporation, and also a machine for the Newcastle and District Electric Light Co.

The "Speedon" Radiator.—We have received from The Coalbrookdale Co., Ltd., of 141, Queen Victoria Street, E.C., a leaflet descriptive of their patent "Speedon" radiator. The apparatus appears to consist of a hot water radiator, in the tubes of which a positive circulation is induced, through the heating effect of an electrical heater placed in a suitable position. The operation of the heater is as follows:—After the first hour or so of working the current should be reduced to about a third of the maximum, and owing to the heat-retaining capacity of the water, the current can be switched off some two hours before vacating the room in which the radiator is placed. If we rightly understand



THE "SPEEDON" RADIATOR.

the intentions of the makers, the probable advantages of the system are not very apparent; from the above the action of heating of the water must delay the imparting of heat to the room, and as during ordinary working, the water merely acts as a transmitting medium for the heat, it would appear that three times the normal (room heating) current is required during the first hour. Furthermore, after-switching off the current, the temperature of the room is gradually falling, so that it is questionable whether this course would be taken by the user, and if it were not, then the delayed heat diffusion, peculiar to this heater, would appear to be wasted.

Polyphase Motors. — Electric driving from the two-phase supply of the Leeds Corporation is making satisfactory progress. Messrs. Harrison, Townsend & Co. have recently put down a complete installation of motors for driving the whole of their large printing works, the sizes of the motors varying from about 4 to 20 H.P. In some cases three or four machines are driven by one motor, but as these are not usually all running together, the motors are worked at their full rated capacity when driving two or three of the machines at once. When all the machines happen to be working simultaneously, the motors may be overloaded as much as from 50 to 75 per cent., but no trouble has been experienced. The motors are of the Churton "P.C." standard type with short-circuit rotors. Messrs. Bateman's Machine Tool Co., Ltd., of Hunslet, Leeds, have also decided to drive their works entirely by means of two-phase motors, the power being obtained from the Corporation supply mains. Three motors of 25 H.P. each at 730 revolutions are to be installed to commence with, and these will be made by Messrs. T. Harding, Churton & Co.

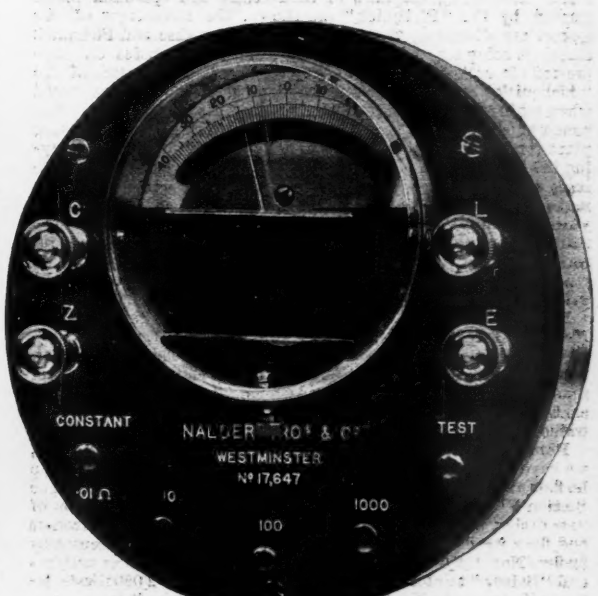
A Birkenhead Charge.—At Birkenhead Police Court on Friday, Charles Martin, electrical engineer, of Birkenhead, was charged with having unlawfully laid electric lines communicating with the Corporation Electricity Supply. For the prosecution it was stated that the wire was connected with the Corporation terminals and that current had been consumed without being registered at the meter. Defendant pleaded that he had no intention of defrauding the Corporation, what he did was merely in order to test an electric lamp, and he omitted to remove the connection when the experiment was completed. The Bench expressed the opinion that they believed defendant had acted without felonious intent, but under the Act they could not impose a lighter penalty than £5.

Plant for Sale.—The Manx Electric Railway Co. is offering for sale the alternating and direct-current plant, also steam boilers, car motors, trucks, &c., at the Douglas and Snaefell power stations. See our "Official Notices" to-day.

Application for Patent Amendment.—Notice is given among our advertisements to-day of an application by Mr. G. G. M. Hardingham, of Clun House, W.C., for leave to amend Specification No. 24,325, of 1902, for "Improved apparatus for use in testing electric lamps."

A Simplex Injunction. — Notice of an injunction obtained by the Simplex Steel Conduit Co., Ltd., against the Metallic Seamless Tube Co., Ltd., appears among our advertisement pages to-day and in our "Legal" columns.

New Testing Set.—A portable insulation testing set of entirely new design, called the "Midget," has been brought out by Messrs. Nalder Bros. & Co., of 12, Carteret Street, S.W. This is illustrated in the accompanying figure; it will be seen that the galvanometer is of the well-known Post Office type, and is provided



NALDER BROS. & CO.'S TESTING SET.

with three shunts, a standard resistance of 10,000 ω—all brought into action by push-buttons—and a test key. Terminals are fitted for battery and line, and the whole is carried in an aluminium box with ebonite top. A clamp lifts the needle off its pivot for transport. With 200 volts, insulation resistances up to 350 megohms can be measured; the instrument can also be used as a sensitive detector. The set weighs 18 oz., measures 4½ in. diameter × 2½ in. deep, and fits into a leather case; it is in a most convenient form for rapid testing.

Catalogues and Calendars.—One of Letts's convenient pocket-books and diaries for 1904, with the usual accident insurance policy, has been sent to us by MESSRS. MCCLURE & WHITFIELD, of Stockport. In addition to the general pocket-book pages, 24 others have been included giving specification and illustrations of the firm's Mersey multipolar and other type generators, enclosed motors, &c. Owing to the continued increase in their business during the past 10 years, Messrs. McClure & Whitfield have had to build new works, and these are now completed and in full swing. The works have been built and equipped on the most up-to-date lines, and place the firm in an excellent position to cope with orders. They are situated in Range Road, Addswood, Stockport.

The LAHMEYER ELECTRICAL CO., LTD., of New Oxford Street, W.C., have sent us a copy of their new list, No. 24, describing their electrically-driven pumps and compressors.

A new list has been published by MESSRS. SMITHSON, SHARPE AND CO., of Sykes Street, Hulme, Manchester, giving particulars of their single enclosure arc lamps and accessories. The vertical single

enclosure lamp, photographic printing lamp, miniature arc lamp, resistances, and lamp terminal weather-hoods are all illustrated and their main features outlined.

An eight-page pamphlet has been brought out by the British Thomson-Houston Co., of Rugby. An attractive cover gives a banner-borne title, "Hints to Users of Electric Light on the Best Means of Securing Maximum Light at Minimum Cost." The costly error of using too cheap lamps is pointed out, also the mistake of straining at getting the longest life with the sacrifice of efficiency. This and other like arguments lead up to a discussion of the merits of the B.T.H.-Edison lamps, for the manufacture of which on a more extended scale the British Thomson-Houston Co., Ltd., have recently added to their works.

Messrs. Hurst, Nelson & Co., Ltd., of Motherwell, have sent us a nicely framed show-card giving several dozen small half-tone photographic reproductions illustrating their various types of build of railway carriages, wagons and electric cars. The pictures include single and double-deck electric tramcars, cantilever and maximum traction trucks, bogie cars, track sweepers and waterers. It is the sort of thing to ornament any office wall.

The New Brotherton Tube Co., Ltd., of Excelsior Works, Commercial Road, Wolverhampton, have issued a large wall sheet giving a calendar for 1904, above which are two fairly large photographic views of two of the bays in their mills where the solid drawn seamless Brotherton tubes are made. Below are given a selection of illustrations showing their new designs of fittings for water-tight electric light conduit installations.

Messrs. Arthur Cort & Co., of 277, Camberwell New Road, S.E., have issued a wholesale price list of insulating hard or flexible vulcanised fibre goods, also gutta-percha and cotton belts, &c.

Messrs. Mavor & Coulson, Ltd., of Glasgow, have brought out a most attractive 40 pp. *brochure*, in which the "Pickquick" coal-cutting machines (Hurd's patent) are capitally illustrated and described. Of the numerous half-tone pictures which show the machines and their different parts, no words of praise can be too high. Interesting diagrams of connections and specimen seams worked by the "Pickquick" are shown, the advantages of the system are discussed, the power absorbed by disc and Pickquick machines being set out in tabulated form. Some notes on compressed-air cutters are followed by testimonials from users of the "Pickquick," and some pages of questions which should be answered when asking for estimates or ordering machines. Sundry electrical memoranda, and some pages devoted to particulars of generating plant for colliery installations, complete the contents. Accompanying the book—which is called the "Red Book" because of its strikingly effective cover—is a circular giving a diagram of the progress made in the sale of the "Pickquick" machines during the past five years. During 1903 the number sold was more than double the total number up till that date, and nearly 40 per cent. were for repeat orders.

Mr. Wm. Middlemiss, of Bradford, have issued a sheet of special prices of their switch blocks, of which large stocks are held.

Messrs. Chambers, Scott & Co., of Dalziel Engineering Works, Motherwell, N.B., have published a new pamphlet (E.C. No. 1,904), in which they give a brief description of their electric overhead travelling cranes. Their standard multimotor cranes which have an independent reversible motor for each motion operated by separate controlling switches from a side cage, are detailed and well illustrated.

From the Edison & Swan United Electric Light Co., Ltd., we have received a further large budget of new leaflets. Four are leaflets of electric light fittings, and are supplementary to Catalogue Section VI. They comprise fancy pendants and table standards of new design, also some very ornamental modern styles of electroliers and floor standards. Electric lighting accessories are represented by leaflets Nos. A. 2,016 and A. 2,023, dealing with patent pear switches and "Safety" tumler switches respectively. No. B. 2,020 illustrates the O.K. dry cell; No. 2,027 describes the "Ediswan" dynamo and motor brushes, and gives comprehensive tables. Nos. W. 2,025 and W. 2,026 are entitled "Ediswan" vulcanised flexible cords, and C.M.A. flexible cords respectively. Leaflet No. H. 2,028 describes "Ediswan" electric light carbons, which are listed in many sizes, both cored and solid, for open and enclosed lamps.

Private Bills in Parliament.—On January 16th further memorials were deposited in the Private Bill Office of the House of Commons, alleging non-compliance with Standing Orders in the case of the following amongst other Bills:—

Cheshire Electricity and Power Gas.—Mr. W. T. Bilson, 10, Mark Lane, E.C., Mr. F. Rogers, of Chippenham, and Mr. R. T. Worth, of Middlewich, allege that the deposited plans are erroneous and defective, and that the books of reference are not prepared in the manner prescribed. Messrs. E. H. Moss, John Bennett, J. Gibbs, and F. Nixon, owners of land in Middlewich proposed to be taken, allege that proper notices have not been served on them.

Torquay Tramways.—The Corporation of Torquay allege that the Dolter Electric Traction Co., who propose to lay down tramways in Torquay, have not obtained their consent as the local authority.

Coulsdon Tramways.—The South-Eastern Railway Co. allege that the Rural District Council of Croydon, who propose to lay the tramways set out in this Bill, have not obtained the necessary consent of the Surrey County Council.

Belfast and North-East Ireland Electricity and Power Gas.—The Corporation of Belfast has deposited a memorial alleging numerous cases of non-compliance with Standing Orders.

On January 18th 31 Bills came before Messrs. Campion and Jeune, examiners of Standing Orders, for proof of the necessary compliance with the rules. Amongst the Bills which were found to have complied with Standing Orders, and to which there was no opposition, were the following of electrical interest:—Harrogate Waterworks Tramroad, Lincolnshire and Yorkshire Electric Power, Baker Street and Waterloo Railway, Charing Cross, Euston and Hampstead Railway, North and South Woolwich Electric Railway, Great Yarmouth Corporation, and St. Marylebone Electric Lighting.

Llanelly Tramways and Improvements.—There was no appearance in the case of the Llanelly Tramways and Improvements Bill which was accordingly marked "Dead." The object of the Bill was to confirm an agreement made between the Urban District Council and the British Insulated and Helsby Cables, Ltd., to transfer the powers of the Council, under their Electric Lighting Order of 1891, to the company, or in the Llanelly and District Electric Lighting and Traction Co., Ltd.; to amend the Llanelly and District Light Railway Order, 1902, by extending the time for the completion of the authorised railways; and to transfer the powers of the Llanelly and District Electric Lighting and Traction Co. to the British Insulated and Helsby Cables Co.

London County Council Tramways.—Messrs. Maple, Ltd., and Messrs. Shoolbred opposed the L.C.C. Tramways and Improvements Bill, in respect of the proposal to make tramways along the Tottenham Court Road, and alleged that the consent of the Holborn Borough Council had not been obtained. The Holborn Borough Council also opposed on the same ground. Mr. Campion found that the Standing Orders had not been complied with, and the Council will accordingly either have to drop the proposed line or ask the Standing Orders Committee to dispense with the Standing Orders.

On January 19th the Examiners had a further list of Bills before them, and found that Standing Orders had been complied with in the case of the following Bills:—Newcastle-on-Tyne Corporation, Radcliffe Tramways, Kettering Improvement, Soothill Nether U.D.C. Tramways, Doncaster Corporation, Portmadoc, Beddgelert and South Snowdon Railway, and Tyneside Tramways and Tramroads Co. The consideration of the Belfast Corporation Tramways, North Wales Electric Power, and the Middlesbrough, Stockton-on-Tees and Thornaby Tramways was postponed.

Rotherham Corporation.—In the case of the Rotherham Corporation Bill, which, amongst other things, proposes to authorise the Corporation to construct tramways in the district of Whiston, it was alleged by the Rotherham Rural District Council that their consent as the local authority had not been obtained. The Examiners found that Standing Orders in the case of tramways 3, 4, 5, 6 and 7 had not been complied with, and the matter will have to come before the Standing Orders Committee, who will decide whether the Bill shall be allowed to proceed.

Amongst the further Bills which have been before the Examiners and of which satisfactory proof of compliance with Standing Orders has been forthcoming are the following, of electrical interest:—Metropolitan District Railway; London, Camberwell and Dulwich Tramways; Ulster Electric Power; Stretford U.D.C.; Lancashire Electric Power; North Staffordshire Railway; Chesterfield Corporation Tramways; Swindon Corporation; Watford and District Tramways; Isle of Thanet Light Railway; Great Northern and City Railway; East London and Lower Thames Electric Power; Manchester Corporation Tramways; Bournemouth Tramways; Saddleworth and Springhead Tramways; Leicester and Warwickshire Electric Power; Metropolitan Railway; North-Western Electricity and Power Gas; Southport and Lytham Tramroad; Preston and Blackburn Tramways; Harrow Road and Paddington Tramways; Derbyshire and Nottinghamshire Electric Power.

Romford and District Tramways.—On Friday last this Bill came before the Examiner for proof of compliance with Standing Orders, but as there was no appearance, the Bill was marked "dead." The object of the Bill was to authorise the Empire Electric Light and Power Co., Ltd., to construct about 3½ miles of tramway in Romford and Hornchurch.

On Monday the following Bills were found to have complied with Standing Orders:—West Metropolitan Railway, Belfast Corporation Tramways, Belfast and North-East of Ireland Electricity and Power Gas, Tottenham Improvement, West Riding Tramways, Wallesey Tramways, Wolverhampton Corporation, and Plymouth Corporation.

Coulsdon Tramways.—This Bill was opposed by the South-Eastern Railway Co. on the ground that Standing Orders had not been complied with in several particulars. The Examiners found that Standing Orders had not been complied with, and accordingly the Bill will go before the Standing Orders Committee.

On Tuesday Standing Orders were found to be complied with in the case of the Preston, Chorley and Horwich Tramways.

Scotch Private Bills.

On Tuesday Messrs. Campion and Jeune sat at the House of Commons to examine as to whether the Scotch Private Bills, promoted under the Private Legislation Procedure (Scotland) Act, had complied with the general orders of Parliament. Any inquiry which may be made into the merits of the Bills will be of a local character, and subsequently the Bills will be remitted to Parliament for reading, and the Royal Assent. The following electrical Bills were found to have complied with the requirements:—

Govan Burgh (Electricity).—To enable the local authority to provide and supply electrical fittings.

Kirkcaldy Corporation.—To authorise the local authority to construct a new additional tramways in the parishes of Kirkcaldy and Dysart and to borrow £65,000 for tramway purposes. Also to give them power to supply electric fittings.

Lothians Electric Power.—To incorporate a company with a capital of £600,000 to supply electricity for power purposes in the whole of the county of Mid-Lothian (except Edinburgh and Leith) and parts of East Lothian, Peebles and Lanark.

Paisley District Tramways.—To extend the time limited by the Paisley District Tramways Order, 1901, for the completion of tramways authorised to be constructed by the Paisley Tramway Order.

Dundee, Broughty Ferry and District Tramways.—This Order

incorporates a company with a capital of £73,500 to construct tramways in the district named.

Clyde Valley Electric Power.—To enable the Clyde Valley Electric Power Co. to acquire the transfer of undertakings of local authorities, &c.

Dissolutions and Liquidations.—A petition presented by creditors for the winding up of the Electric Tramways Construction and Maintenance Co. is to be heard on February 2nd in London.

A meeting of the English Electrical Engineering Co. (now amalgamated with Dick, Kerr & Co., Ltd.) is to be held at Abchurch Yard, E.C., on March 3rd, to hear an account of the winding up by Messrs. R. H. Prestwich and T. D. Lingard, the liquidators.

Messrs. W. Swire & P. Derbyshire (Swire & Derbyshire, plumbers and electrical engineers, 2, Great George Street, St. Helens) have dissolved partnership.

The P. & R. Storage Battery Co., also Peto & Radford, Ltd., are winding up voluntarily, with Mr. William Peto, of 57B, Hatton Garden, E.C., as liquidator.

Mr. F. S. Salaman, of 2, Oxford Court, Cannon Street, E.C., has been appointed liquidator of the South-Western Electrical Co., Ltd., in place of Mr. C. E. Peebles, resigned. Creditors should send in particulars of debts, &c., by March 1st.

Messrs. C. Ross and W. H. Price (Ross, Price & Co., electrical engineers and contractors, Walsall) have dissolved partnership. Mr. Price will attend to debts.

Trade Announcements.—The businesses of Messrs. Atkinson, Schmahl & Co., and the Armorduct Improved Electric Conduit Co., both of 5, St. Nicholas Buildings, Newcastle-on-Tyne, have been amalgamated under the style of The Armorduct Manufacturing Co., Ltd., with head offices at 6, Farringdon Avenue, London, E.C. This company takes over the businesses as going concerns as from January 1st, 1904, and will attend to all debts. The new company has also absorbed the business of Alan Robson & Co., of 8, Eldon Square, Newcastle-on-Tyne, but Mr. A. G. Robson will carry on that business as a local branch of the Armorduct Co. The St. Nicholas Buildings offices are now discontinued, but large stocks are carried at Eldon Square. The debts relating to Robson & Co. will be settled by Mr. Robson personally. The new company will devote itself particularly to "Armorduct" conduit, and insulated wires and cables of every description, and also to the supply of electrical accessories.

Mr. H. D. Haigh, of Huddersfield, has been appointed manager of Psychiloid, Ltd., Insulating Works, Love Street, Sheffield, in succession to Mr. R. G. Mercer, A.M.I.E., who has resigned in order to take up an appointment with the British Westinghouse Manufacturing Co.

The London Electrical Fittings Co., Ltd, of Roberts Works, Hampstead Road, N.W., have just opened, for the convenience of the trade, a spacious ground-floor showroom, at 7A, Soho Square, W., where all their latest designs in electric light fittings and heaters may be seen. They are just putting on the market a very novel two-light patent counterweight, which has an adjustable range between the holders of 24 in. to 12 in., without spoiling the effect of the curves in the fitting.

M. & P. Pumps.—An order has lately been placed by the General Electric Co., of the United States, with Messrs. Mather and Platt, Ltd., for 14 of their special type centrifugal pumps for high lifts. These pumps will be driven by G.E.C. motors connected through flexible couplings; and are intended for use in two gold mines in India; six pumps will be connected in series in each mine, the seventh being a spare.

Annual Dinners.—The Norwich Tramway Co.'s employés' annual dinner, as guests of the company, was held last week.

The annual dinner in connection with the Manchester branch of General Electric Co., Ltd., took place on Saturday last at the Midland Hotel, Manchester, when about 150 of the chief employés at the company's Manchester works assembled, with Mr. A. Eckstein, one of the managing directors, in the chair. In proposing the toast of "The Staff," Mr. Eckstein spoke of the prosperous condition of the company's business, and traced the progress made by it during the last 14 years. Competition, he said, was exceedingly keen, but, by united efforts, they need have no fear as to the future. Mr. Max Byng replied to the toast of the directors, and said the company was never in such a flourishing condition as it was to-day.

Imports of Foreign Electrical Goods.—There was an unusually large importation of foreign electrical goods and apparatus into this country during December last, a total of £86,969 being recorded, as compared with £82,944 in the preceding month, and £61,368 in December 1902. The aggregate imports last year amounted to £819,057, this contrasting with only £687,514 in 1902.

The Taxation of Machinery.—The Machinery Users' Association has met with a signal success in defending the manufacturers of Derby against the attack made upon them by the Derby Assessment Committee. This attack commenced about two years ago with the object of increasing the taxation levied upon the manufacturers of the district. The local taxation had then reached the sum of 7s. 6d. in the £ on the rateable value, and with the further expenditure which the authorities contemplated in various enterprises, it was obvious that while it was necessary to raise more money to pay the interest on this expenditure, the ordinary ratepayers would not submit to any increase in the existing high poundage of the rates. Under these circumstances, we are told, the only means of obtaining this money open to the rating authorities, was to increase the rateable value of the district by bringing into assessment the valuable machinery belonging to the occupiers of the numerous factories. These were accordingly singled out for the attack, and special instructions were given to a professional valuer to employ his skill in raising their assessments. The result of these operations was, no doubt, satisfactory for the time being to the originators of the scheme, for the aggregate rateable value of the firms affected was raised by those valuations by a sum of £12,000, representing an annual payment of local rates of £4,500. The manufacturing interests of Derby, however, were not disposed to submit tamely to these proceedings, and having decided upon combined action, they retained the services of Messrs. Eddowes & Sons, solicitors, of Derby, and of Messrs. Humphreys-Davies & Co., of London, the valuers to the Machinery Users' Association, with whose advice and assistance not only was the attack carefully defended, but a vigorous onslaught was made upon the attacking authority, the first result of which was that on May 19th, 1903, the King's Bench decided that the Poor Rate had not been legally made.

The authorities having no doubt been advised that their attempt to rate the occupier's machinery was illegal, these proceedings have finally culminated in their having agreed to a resolution by which they have abandoned their own valuations and agreed to accept those of Messrs. Humphreys-Davies & Co., with an addition of 7½ per cent. thereto, to cover any possible bias by which those valuers might have been unconsciously animated in making their valuations at the instance of the appellants.

It is difficult to understand how the Derby authorities could have ventured to have made this irritating attempt upon machinery users, having regard to the Act of Parliament of 1840, which expressly provides that personal property shall not be rated, and to the decisions which have recently been given upon this question not only at the Quarter Sessions, but in the King's Bench. The manufacturers are to be congratulated upon their successful resistance, which shows the necessity for the vigilant organisation of the Machinery Users' Association, and of united action on the part of the manufacturers throughout the kingdom to resist successfully both in Parliament and in the courts, attacks of this kind which, unfortunately, are now far too frequent in all parts of the country.

The G.W.R. Power Station at Park Royal.—In connection with the announcements recently made respecting the giving out of the contracts for this plant, the directors and engineers have selected Messrs. Belliss & Morcom's standard design, forced lubrication, quick-revolution engines, eight of which will develop an output of 1,080 B H.P. each, normal load, and 1,250 B H.P. each at maximum load, when coupled up to three-phase generators which will develop 750 KW. each at normal load at 6,300 to 6,600 volts, and are capable of a 25 per cent. overload for one hour. The engines will be of the firm's well-known triple-expansion, three-crank, vertical, enclosed type, to work at a steam pressure of 190 lbs. with superheated steam of 500° F. at the engine stop valve. We are informed that very stringent conditions are attached to the contract with regard to governing and steam consumptions, which, however, with the large experience which they have had in the manufacture of similar and larger size engines of the same type previously built by them for central stations, Messrs. Belliss & Morcom are confident of achieving. In addition to the eight large sets, there will be two auxiliary engines and dynamos for lighting and power work, one set to drive a three-phase generator, the other to drive a continuous current dynamo. The engines in this case will be of the Belliss two-crank compound design, otherwise of similar type to the large engines, and will also work under superheated steam. For condensing, the firm will supply four of their surface condensing plants, each set consisting of surface condenser with 4,200 sq. ft. cooling surface, with two-crank, vertical, side by side, compound, air pumping engine, fitted with Edwards type air pump of their own make. The circulating pump will be of their centrifugal type, driven direct by a small three-phase induction motor.

Book Notices.—"*One and All*" *Gardening*, 1904. Edited by E. O. Greening. London: The Agricultural and Horticultural Association, Ltd.—This is an advance copy of this popular annual for amateur and other gardeners. There are some 200 profusely illustrated pages, a generous allowance for the price (2d.), and a very large sale is anticipated, as usual. It is a useful book for anyone who takes the least pride in his bit of garden—but dare we venture to hope for some gardening weather again?

The Electrical Magazine. Edited by Theo. Feilden. No. 1, Vol. I. January. 6d. monthly. London: Electrical Publishing Co., Ltd., 4, Southampton Row, Holborn, W.C.

"Papers and Reports Relating to Minerals and Mining in New Zealand." Wellington: John Mackay, Government printer.

"Fire Tests with Doors." No. 77. London: The British Fire Prevention Committee. 2s. 6d.

LIGHTING AND POWER NOTES.

Aberdeen.—The T.C. has resolved to borrow a further sum of £65,000 for the electric lighting undertaking, making the total sum borrowed to £250,000.

Basingstoke.—The ratepayers, at a statutory meeting held recently, rejected the proposals of certain members of the Corporation to establish a municipal electricity works for lighting the borough.

Beeston.—The U.D.C., under its prov. order, proposes to buy energy in bulk at 1½d. per unit from the Notts and Derbyshire Electric Power Co., and supply consumers at 6d. per unit, wiring free.

Bradford-on-Avon.—The R.D.C. has decided not to oppose the application of the Western Electric Distributing Corporation for a prov. order to supply energy within its area, with the exception of the parish of Holt.

The company offers to supply energy for lighting at a maximum price of 7d. per unit, and for power at 3d. per unit.

Bridlington.—The L.G.B. has given its consent to the borrowing by the Corporation of £26,481 for the electric lighting scheme, the repayment period allowed being 25 years.

Brighton.—The B. of T. has approved of the Corporation's scale of charges for energy supplied to the parishes of Patcham and Preston.

Carnarvon.—A special meeting of the T.C. was held to discuss the electric light question, a writ having been served on the town clerk by the wiring company, with whom the Council had at one time been negotiating, with a view to supplying the town with electricity. It was decided that a deputation should meet representatives of the company and treat with them, offering payment of out-of-pocket expenses incurred by the company without admitting the Council's liability.

Cleethorpes.—The U.D.C. has resolved to oppose the Bill of the Lincolnshire and Yorkshire Electric Power Co.

Croydon.—The T.C. has resolved to seek powers by the insertion of a clause in the next local Bill before Parliament to supply, in bulk or otherwise, electricity to any person, company, or local authority outside the borough.

The T.C. has also authorised steps to safeguard its interests in regard to the Beddington, Coulsdon and Sanderstead E.L. prov. order.

Derry.—The Derry Gas Light Co. has notified the Corporation of its intention to sue for damages done to its mains and connections in the process of laying the cables for electric lighting. The Corporation referred the company to the contractors, but the company decided to hold the Corporation responsible.

Foots Cray.—At a ratepayers' meeting held recently in the Public Hall, Sidcup, to consider the question of the U.D.C. proceeding with its electric lighting order, the proposal was rejected by a large majority. A poll of the district is to be taken.

Gillingham.—The T.C. has decided to connect up its mains to the Royal Engineers' Barracks at Old Brompton, and to Government House, Chatham.

Glasgow.—A deputation has been appointed to visit Newcastle and other English towns to inspect turbine plant used for generating electricity.

Greenock.—On the recommendation of the Electricity Committee, the Corporation has resolved to adopt the motor-hiring system.

Halifax.—The Tramways and Electricity Committee is considering an application from the Sowerby Bridge U.D.C. for a supply of electricity to its area.

Ham.—At the meeting of the U.D.C. on January 21st, a letter was received from Edmundson's Electricity Corporation, consenting to the charge for energy for public lighting being reduced from 2½d. per unit to 2d. The Council, however, decided to withhold consent to the company's application for a prov. order until it had ascertained what the company propose to charge for private lighting.

Hanwell.—The T.C. has written to the Southall-Norwood U.D.C., stating that it will be willing to pay Southall a royalty of 1d. per unit on all electricity supplied to the Hanwell Asylum, which is in the Southall district.

Hull.—The Parliamentary Committee of the T.C. has decided to oppose the Lincolnshire and Yorkshire Electric Power Bill.

Italy.—A concession has been granted to put down a plant to utilise the water-power of the River Brembo at San Pellegrino for generating electricity for power purposes.

Johannesburg.—A company has been formed to erect an electric power station to supply energy to the mines. A proposal has been made to the T.C. to supply the town for lighting and traction purposes, &c., also, and so obviate expenditure on a municipal scheme.

Johnston.—The T.C. has agreed not to oppose the scheme of the Clyde Valley Electric Power Co. for the lighting of the town, if the company inserts a clause giving the Corporation the option of purchase in 21 years, and conceding all the privileges given to other burghs, excepting Clydebank.

Keynsham.—After submitting the terms of the E.L. prov. order promoted by a company to the various parish councils, all of which unanimously opposed it, the U.D.C. has resolved to apply for a prov. order to light the district itself.

Leeds.—The City Council has unanimously agreed to take a poll of the ratepayers before proceeding with the Consolidation Bill in Parliament. Certain clauses in the Bill are to be opposed by the Yorkshire Electric Power Co.

Lichfield.—At a meeting of the Ratepayers' Association held recently, it was resolved to support the Corporation in obtaining a prov. order for lighting the district by electricity.

Llanwrst.—The U.D.C. has been informed that two offers have been made to purchase the Llanwrst and Trefriw Electricity Supply Co.'s undertaking as a going concern, the prov. order for the lighting of Trefriw to be included in the transaction. The T.C. has called a meeting to consider the question of a purchase.

London.—Marylebone.—The poll of the ratepayers, which is to decide the fate of the Bill empowering the B.C. to complete the purchase of the Electric Supply Co.'s property, is to be taken on February 8th. The company agrees not to actively enforce the judgment of Mr. Justice Buckley for the payment of £60,000 by the Council, pending the poll. On the suggestion of the Mayor the Council has decided to continue its negotiations with the company with a view to a compromise.

Camberwell.—The General Purposes Committee of the B.C. has received from the Board of Trade, a copy of a letter sent to the undertakers under the Crystal Palace and District Electric Lighting Orders, 1890 and 1894, enclosing a description of the system of supply of electrical energy, which had been approved by the Board of Trade, for the Blackheath and Greenwich District Electric Light Co., Ltd., in the event of that company acquiring the whole or a part of the undertaking, authorised by that Companies' Act, 1903. The system approved is a high-pressure alternating two-phase supply at a frequency of 50 periods, to transformers placed, in some cases, on consumers' premises or in sub-stations, but mainly in street boxes; distributing mains will be laid for a two-phase or single-phase alternating current low-pressure supply on the two-wire system.

St. Pancras.—At the termination of the present quarter the charges for energy to theatres and music halls will be reduced to 4d. per unit.

Westminster.—The Works Committee of the City Council has approved the plans for the construction of a new motor-generating station in Duke Street Gardens, Grosvenor Square, by the Westminster Electric Supply Corporation.

Battersea.—The Lighting Committee of the B.C. has decided to reduce the charges for energy through prepayment meters from 5d. to 4d. per unit.

Hackney.—The Committee of the B.C. has recommended the presenting of a petition against the East London (Lower Thames) Electric Power Bill, and that other Councils affected, be asked to take similar action.

Hampstead.—The B.C. has decided that 48 new house-boxes be provided in place of the old ones now in use, at a cost of £168.

A statement from the electrical engineer shows that 4,086,750 units were generated at the electric lighting station in 1903, as compared with 3,068,229 units in 1902. The number of lamps connected was 206,217, and consumers, 3,550.

Islington.—The B.C. has resolved to expend an additional £640 upon mains, extensions and additional arc lamps.

Loughborough.—The T.C. has sealed an agreement with Messrs. H. Morris & Bastert, for the supply of electricity in its area.

Maidstone.—The U.D.C. has decided to introduce the slot-meter system for consumers.

Mexbrough.—In order to meet the increased demand for energy caused by the Great Central Railway Co. having decided to light its station, works, and goods yards from the U.D.C. generating station, additional plant has been installed.

Mytholmroyd.—The U.D.C. has decided to ask the Halifax T.C., the Hebden Bridge U.D.C., and the Yorkshire Electric Power Co. upon what terms they are prepared to supply electricity either in bulk or otherwise.

Newton Abbot.—The U.D.C. has resolved to endeavour to get a clause inserted in the draft prov. order, under which the Urban Electricity Supply Co. should be required to sever the connection between the U.D. and the parish of Kingsteignton, should the Council desire to purchase the undertaking. If possible it will oppose the company supplying energy to Kingsteignton. The Council has asked the company if in the event of it not opposing the company's order for extending the mains to Highweek and Milber, whether the company will consider a reduction in price to public and private consumers.

Rawmarsh.—The U.D.C. has decided to ask the B. of T. to extend the time in which to carry out the E.L. order. The Council has also approached the New General Traction Co. relative to working the order.

Sydney.—In connection with the extensions of plant at the Ultimo power station, the Railway Commissioners have decided to accept the tender of Messrs. James Howden & Co., of Glasgow. The tender provides for a steam turbine plant by Messrs. C. A. Parsons & Co., and Babcock & Wilcox water-tube boilers, with automatic stokers. The cost of the additional plant will be about £48,000, and it is expected to be in working order in about 12 months hence.

Santos.—The City of Santos Improvements Co., Ltd., of London, who own the gas lighting system, is purchasing the tramway and electric lighting systems and concessions of the Companhia Ferro-Carril Santista, for £115,000, mainly in shares and debentures.

Tavistock.—The resolution passed by the ratepayers assenting to a private company obtaining a prov. order to light the district by electricity has been confirmed by the T.C.

Venice.—According to the *Board of Trade Journal*, a company has been working for the past two years, to utilise the water power of the River Celina for introducing electrical energy for light and power in the town, and it states that there is an opportunity for manufacturers to introduce electrical appliances.

Walthamstow.—At the last meeting of the U.D.C. the electrical engineer submitted some figures on the return on capital expended in wiring and lighting small house property. Lansdowne Road: actual capital expenditure: cables, £106 9s. 11d.; house services, £100 3s. 10d.; lamp services, £8 12s. 6d.; meters, £99, free wiring, £160 10s.; total, £474 16s. 3d. Actual net revenue: rental, £18 15s. 5d.; connection charges, £8 5s.; revenue from five lamps (when connected), £8 2s. 6d.; total, £25 2s. 11d. Net profit, after paying interest and sinking fund, amounted to 7·4 per cent. on capital expended. He points out that out of a total of 700 customers in Walthamstow, only three have discontinued using the electric light since the works were first in operation—2½ years ago. He further reported that the total number of 8-c.p. lamps applied for was 40,600, as against 29,862 12 months ago.

Wimbledon.—A L.G.B. inquiry into the application of the U.D.C. for a loan of £11,000 for extending the E.L. system to Merton was held recently. The clerk asked for the loan to be reduced to £5,462, as negotiations for supplying a large estate company in bulk had been broken off.

York.—Considerable annoyance has been caused recently both to the public and the Corporation officials by the failure of the electric light in parts of the town. On Sunday last the trouble was found to be caused by some unauthorised person obtaining access to the switchboard and cutting off part of the supply. The matter has been placed in the hands of the police, and arrangements have been made to preclude the possibility of any further tampering at the works.

During the period between December 22nd to January 5th the York police reported that 30 gas lamps were found out and six defective; 94 electric lamps out and five defective; and between January 5th and 19th, 44 gas lamps out and six defective; in the same period 179 electric lamps out and 12 defective. On the night of January 4th 16 arc lamp globes were broken, and on January 11th 95 gas lamps were broken. Acts such as the latter appear to be the result of deliberate malice.

TRAMWAY AND RAILWAY NOTES.

Argentine Republic. — The Capelitas Mining Co., which is extensively engaged in copper mining, is putting in a modern plant, including electrical motors and an aerial railway operated by electricity.

Batley.—Our Dewsbury correspondent writes:—Major Druitt, R.E., Board of Trade Inspector, conducted an inquiry on Friday last at the British Electric Traction Co.'s depôt at Liversedge, into the accident which occurred on the Batley section of the tramways on the 16th inst. A car jumped the metals in Thorncliffe Road and dashed through a garden wall. The car was considerably damaged, and several of the passengers were more or less seriously injured. Major Druitt, who was accompanied by representatives of the Traction Co., the Westinghouse Co., and the Batley Corporation, inspected the lines where the accident occurred, and also tested the car. The inquiry was conducted *in camera*, but we learn that no fault was found with the metals, which were constructed by the Batley Corporation and leased to the company. It is also stated that both the car and brakes were in perfect order, and the suggestion is that the accident can only be attributed to carelessness on the part of the driver.

Birmingham.—There was a complete stoppage of the traffic on the Aston Road route on 26th inst. for 1½ hours, caused by the breaking of a suspension arm supporting trolley wire in Steelhouse Lane. The wire did not give way.

Bolton.—The Corporation Tramways Committee has resolved to have 35 cars fitted with the Phillipson lifeguard and 35 with the Wilson Bennett lifeguard.

Brighton.—The Tramways Committee have instructed the engineer to report on the advisability of connecting the east end of the town with the Old Steine by way of a tramway up St. James Street.

Calais.—The Calais Tramways Co.'s application for an extension of the concession, and the conversion of lines to electrical traction, is still under consideration by the authorities at Paris.

Dunedin, N.Z.—Mr. F. H. Chamberlain, engineer to the Christchurch Tramway Board, recently visited the town and obtained information regarding its tramway systems. There is between seven and eight miles of track laid down. All the cars are single-deckers. A system is shortly to be laid down at Christchurch, and the same type of car has been decided upon.

Electric Railways in Germany.—Reuter's agent at Berlin says that, in the Reichstag on 26th inst., the question of fast electric railway travelling was raised. Herr Budge, Minister of Public Works, stated that the matter was still in its preliminary stage, and that, in connection with the project, the principles of suspension railways and monorail systems came under consideration. As regarded fast travelling of that nature, only the very first experiments had been made, and he could not accept the responsibility of authorising the use of such railways for travellers generally. It was also very far from clear whether the scheme would be practicable for economic purposes. The trials would be continued with due caution. The experiments on the line between Berlin and Grosslichterfelde were giving very favourable results. Soon they would be able to witness practical experiments with the Electric City Railway in Hamburg. The Prussian Government would at the time take all possible advantage of the results of these trials.

Electric Signalling on the L. & Y. Railway.—It is stated that the directors of the Lancashire and Yorkshire Railway have placed a contract with the British Westinghouse Co. for a full installation of "all electric" signalling on their main line between Manchester and Rochdale. In September last an installation of electro-pneumatic signalling was completed at the new passenger station of the railway company at Bolton.

French Railways.—The General Council of the Haute-Vienne has decided upon the construction of a system of departmental railways to be worked electrically, and comprising the following lines:—(1) From St. Mathieu to St. Sulpice; (2) from St. Julien to St. Sulpice; (3) from Chateauponsac to Buissières Poitevine; (4) from Cieux to Nantiat; (5) from Limoges to Fymoutiers; (6) from Richechouart to La Naxon; (7) from St. Yrieix to St. Germain. The total length of the proposed system will be a matter of 411 km. The energy will be furnished by different waterfalls in the district. Propositions are invited for the concession of the construction and working of the proposed system. They should reach Le Conseil Général de la Haute-Vienne, France, not later than March 15th next.

Glasgow.—The T.C. has withdrawn the proposed extensions of its tramway lines to Bevisden and Mengame; from Spier's Bridge to Barrhead; and from Giffvoch to Whitcrays.

The T.C. has decided not to extend the halfpenny fare distance meantime.

Greenock.—Mr. J. A. Robertson, the burgh electrical engineer, has recently reported at length upon the effect of the arbitration award (see ELEC. REV., November 20th, 1903) upon the finances of the electricity department. The most important question of all was that relating to the price to be paid by the tramways company for energy in excess of the minimum of 500,000 units per annum. The report goes into the question of cost of production, and compares it with the price receivable under the award, and concludes thus:—

"It is too early yet to estimate with any degree of accuracy the effect of the award on the finances of the department for the two years from May 15th, 1903, to May 15th, 1905, at which date a revision of prices takes place. As the business of the electrical undertaking develops, due to the increased use of electricity by private consumers, the costs of production will naturally tend to decrease all round, and at the present time the works costs are substantially lower than they were during either of the preceding years. It should be borne in mind, however, that the standing charges against traction supply hitherto have only provided for the redemption of the capital expended on the plant in the somewhat long period of 30 years. The wide variations in the tramway load throw an unusually severe strain on the generating engines and dynamos, and, in my opinion, it will be necessary at an early date, in addition to paying off the capital by means of a sinking fund, to make a liberal allowance for depreciation of the plant used for traction purposes. My opinion is, after the most careful consideration of all the circumstances, that even when due allowance is made for extension of business and decreased works costs, it will be quite impossible to show any profit as a result of supplying the tramway company with energy during the next two years, and I think that when the time comes for revision in 1905, every possible effort should be made to reverse a decision which has undoubtedly inflicted a serious injustice on the Corporation."

Guildford.—The Light Railway Commissioners have granted the application of the West Surrey Light Railway Co., for an order authorising the construction of an electric tramway from Guildford Junction Station to Pitch Place.

Halifax.—The Tramways Committee is stated to have replied in the negative to a request from the legal representative of a wealthy syndicate asking if it is prepared to relinquish certain of the powers which it possesses with regard to the laying of tram lines from Halifax to Brighouse, the object of the syndicate being apparently to connect Halifax, Elland, Brighouse and Huddersfield, by tramways. A similar request was made to Brighouse.

Hamburg Electric Railways. — The Continental Electric Co., of Nurnberg, has under consideration a project for the construction of an overhead railway, to be constructed on the same system as at Elberfeld, but embodying certain improvements and modifications. The object of the new line is to secure a rapid means of communication between the centre of the town of Hamburg and its suburbs. Ordinary traffic will be worked on the simple

unit system, but in case of heavy traffic the multiple unit system will be adopted as the occasion demands, and the stations will be constructed of sufficient length to accommodate a train of six motor-cars. Each car will be capable of accommodating about 85 passengers. Passengers will enter at one side of the carriage and leave it from the other. A five minutes' service will be established ordinarily, but at certain hours of the day a service will be given every 2½ minutes. The promoters count upon an annual traffic of 93 million passengers.

Liverpool Electric Railway.—On Sunday several experimental runs were made from Formby to Southport on the new electric railway. The trials were perfectly satisfactory. Trials were made with several different trains on the Crossens section to Formby and *vice versâ*, and these were also a great success. The permanent way is finished right through the entire length to Liverpool, but the delay in opening it is caused by the incomplete condition of the sub-stations at Seaforth and Sandhills.

London.—ST. PANCRAS.—The B.C. has passed a resolution expressing the opinion that it is desirable that one system of tramway electrification shall be adopted throughout the borough, and requesting the L.C.C. to reconstruct the whole of the lines on the conduit system.

Manchester.—The receipts for last year in Manchester were £488,245; in Glasgow, £459,951; in Leeds, £230,400; in Salford, £160,578; in Bradford, £157,837. The Tramways Committee takes a benevolent interest in the welfare of their employés. Under the patronage and with the help of the general manager, Mr. J. M. McElroy, a social and athletic society, membership of which is open to all the 3,000 men employed by the Committee in various capacities, has been formed. The management is entrusted to a committee chosen by the drivers, guards and other workmen in the traffic department, and rooms are provided for the members' convenience at the Queen's Road and Hyde Road depôts. At the opening, which took place last week, Mr. Boyle, the chairman of the Committee, attended, and gave an address.

Newcastle (Staffs.).—The Corporation having refused to sanction the construction of a double tramway line through certain main streets of the borough, by the Potteries Electric Traction Co., unless the company first lay down a projected line between Trent Vale, one of the suburbs, and the town, the company's manager, on Thursday last, waited upon the Corporation and offered to run a service of automobiles, as an experiment, between Trent Vale and the town. The Corporation has asked the company, as a condition to its sanction of the double line, to run a regular service of automobiles for a period of five years, at the end of which time, if they had proved remunerative, the company must either construct the tramway to Trent Vale, or continue to run the automobiles for a further period of five years. The matter is to be brought before a meeting of the company's directors next month.

New South Wales.—The revenue from tramways during the quarter amounted to £207,667, as compared with £190,951 during the December quarter of 1902. The expenditure amounted to £179,642, as compared with £167,915.

Ossett.—The Corporation's application for powers to construct an electric tramway within the borough, as part of the line from Ossett to Dewsbury, is to be opposed by the Great Northern Railway Co., the Yorkshire Electric Power Co., the Wakefield and District Light Railway Co., and by certain property owners, who consider that a tramway would cause their property to deteriorate in value. It is also contended that in some places the road is too narrow, but some of the objectors would be satisfied if the Corporation undertook to widen the thoroughfare. The Wakefield and District Light Railway Co. hold that the plans are too extravagant, and the Yorkshire Electric Power Co. point out that they have a station at Thornhill, and could supply Ossett with power, thus effecting a saving in the rates.

Paris Metropolitan Railway.—In regard to the note which appeared in this column last week, we are asked to state that an order for certain equipments had been placed some time previous to the fire, and the order in question is merely a continuation of the old one, but with the stipulation that the original order should be altered to include the more recent modifications in the system. The French Thomson-Houston Co. have just received a new order from the Paris Metropolitan Railway for 100 complete equipments on the system of train control in use on the Central London Railway, Great Northern and City, North-Eastern Railway, and Metropolitan and District Railway, which contract was given after investigation of all systems on the market. The order now placed is all for new equipment in addition to that heretofore in use or on order, and is the only additional equipment ordered by the Paris Metropolitan.

Peru.—The Empresa Electrica de Santa Rosa has just built a power station at Chosica, to develop 1,700 H.P., with provision for increase. This is in addition to the 1,800 H.P. plant established near Lima three years ago. The company will supply energy to the nearly completed electric line between Lima and Miraflores, as well as to a line under construction from Lima to Callao. The equipment of the power houses and railways is in the hands of American firms.

TELEGRAPH AND TELEPHONE NOTES.

Portsmouth Telephones.—The town clerk has received a letter from the L.G.B. in reference to the recent application of the Corporation to borrow £12,000 for an extension of the system, while, acceding to the proposals for extension within the borough, the L.G.B. decline to sanction the borrowing of money for carrying the wires into the country districts on the ground that the probable financial return would not warrant the outlay. Sums for other purposes, including the laying of ducts in Lake Road (within the borough), have also been struck out, the net result being that the Corporation are authorised to borrow only £8,988 instead of £12,000 asked for. Much of the money asked for has already been expended, including some upon extensions, which have been disallowed. The Telephone Committee will, it is understood, make a strong appeal to the L.G.B. to reconsider their decision.

Telegraphic Interruptions and Repairs :—

CABLES.	INTERRUPTED.	REPAIRED.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
St. Lucia-St. Vincent	Sept. 19, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
St. Kitts-Antigua	Jan. 8, 1904	Jan. 18, 1904
Mole St. Nicolas-Port-au-Prince	Dec. 16, 1903	
Cayenne-Pinheiro	Aug. 18, 1902	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tourane-Amoy	Nov. 10, 1903	
Tarifa-Tangier	Jan. 18, 1904	
LANDLINES.		
Swakopmund-Windhuk (beyond Karibib)	Jan. 20, 1904	

CONTRACTS OPEN AND CLOSED.

OPEN.

Battersea.—February 15th. 750-KW. steam dynamo, electric pumps and pipework. See "Official Notices" to-day.

Bedford.—February 9th. Switchboard for electricity works. See "Official Notices" to-day.

Bristol.—The Corporation is anxious to receive from manufacturers, particulars of their standard single-phase H.T., and three-phase E.H.T. switch-gear. See "Official Notices" Jan. 22nd.

Canterbury.—February 8th. Four motor-driven pumps. See "Official Notices" January 22nd.

Chili.—June 28th. Tenders are being invited for the public electric lighting of the city of Punta Arenas (Straits of Magellan), which will be opened on June 28th next, at 2 p.m., in the offices of the Municipal Commissioners of that city. Full particulars can be obtained on application to the Chilian Legation, 29, Queen's Gate Terrace, S.W.

Edinburgh.—February 22nd. Engine and dynamo of large size. See "Official Notices" January 22nd.

Hammersmith.—February 10th. General stores for the electricity department. See "Official Notices" to-day.

Hanley.—February 22nd. 500-KW. steam or turbo-alternator, condensing plant, superheaters, &c, for the electricity works. See "Official Notices" to-day.

Hastings.—January 30th. Supply of alternating current motors on hire-purchase agreement. See "Official Notices" January 22nd.

Hornsey.—February 8th. Two dryback boilers, smoke consuming apparatus, 100 and 300-KW. steam dynamos, motor-generators. See "Official Notices" January 8th.

Islington.—February 17th. Free wiring, and motor hiring. See "Official Notices" to-day.

Islington.—February 24th. Conduits and mains. See "Official Notices" January 22nd.

Kirkcaldy.—February 1st. Seven motor-cars for the Corporation. See "Official Notices" January 22nd.

L.C.C.—February 2nd. Tenders are being invited for roadwork and platelaying for the electrifying of certain tramways in South London. Particulars, &c, at the Engineer's Department, L.C.C.

L.C.C.—February 9th. The Council is prepared to receive tenders for the supply and delivery of eight railway turntables, and for the erection of the same at the Council's generating station, Greenwich. Specification, &c. (£2), at the County Hall, Spring Gardens, S.W.

(*Continued on page* 184.)

THE GREAT NORTHERN AND CITY ELECTRIC RAILWAY.

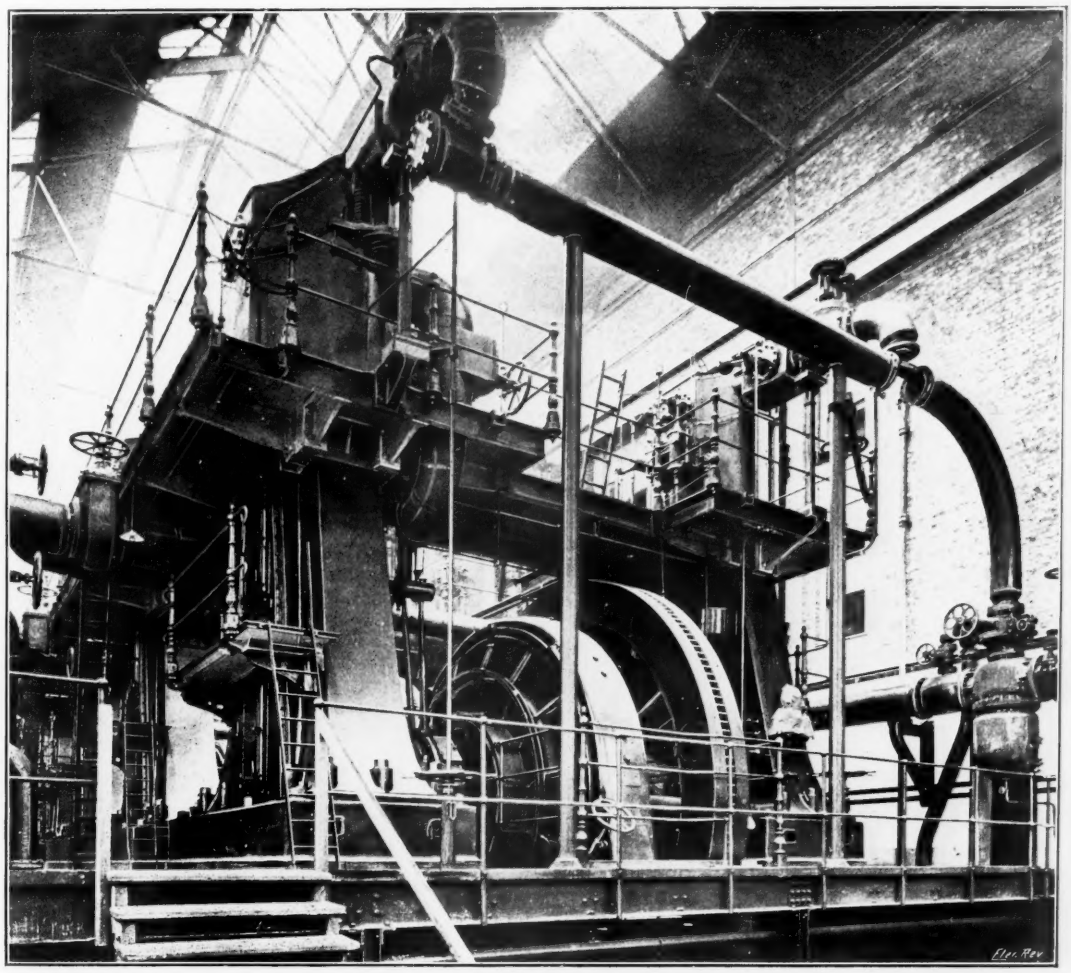
(*Continued from page* 135.)

To deal with the heavy traffic between the City and the suburbs, it is necessary to have a rapid and frequent service of trains; and as the stations are comparatively near together, it is essential to employ a high rate of acceleration to ensure a rapid service. Another requirement of the line is that the trains must be capable of operation in either direction and from either end, so that the time and space required for the shunting of a locomotive at the crowded termini may be avoided. After a thorough consideration of the merits of the different systems, the Great Northern and City Railway Co. decided to equip their trains with the multiple-unit system of the British Thomson-Houston Co., Ltd., which is especially designed to fulfil the above requirements.

It is proposed to run a three-minute service of seven-coach trains, the single journey being completed in about 13½ minutes, including three intermediate stops of 20 seconds each.

The trains will be worked on the shuttle principle at the termini, and it is intended to complete the double journey in 30 minutes. With this service there will be 11 trains running. The trains, which will weigh about 200 tons when normally loaded, will have a seating capacity of 505 passengers each, and will be composed of three motor-cars and four trailers. During the hours of light load the trains will be reduced to four cars, if necessary, retaining the three-minute service.

The rails are laid to standard gauge on longitudinal sleepers in the tunnels, while that part of the track which is in the open is of the standard type, with cross sleepers. The track and tunnels are arranged to allow of the existing Great Northern rolling stock running over the line, should extensions and a connection be made with that line, the tunnels being of ample size to take these coaches, even with the door open.

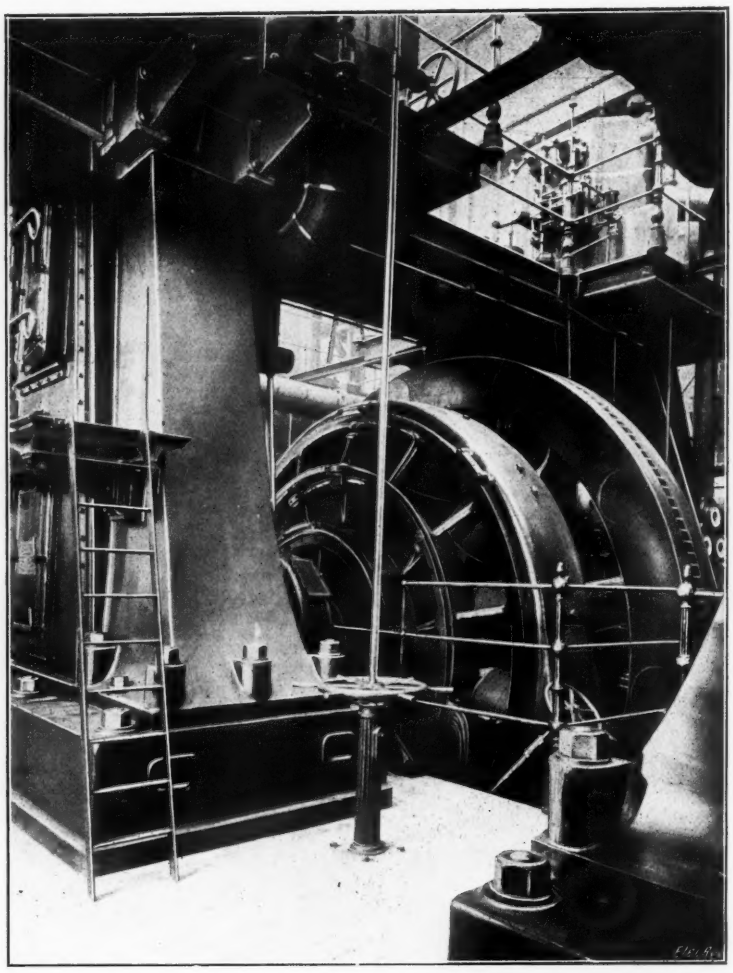


Musgrave-British Thomson-Houston 800—1,200-kw. Generating Set.

The power for operating the system is supplied from a single generating station located at Poole Street, New North Road, approximately a little over a mile north of Moorgate Street station. From this power station the current is fed direct to the collector rails. The length of line and the position of the generating station are such as to enable the system to be economically operated without feeding at any

other points, while using a collector rail of convenient section.

As may be seen from the plan and section given on p. 183,



300—1,200-kw. B.T.H. Railway Generator.

considerable ingenuity has been displayed in the arrangement of the necessary plant in the limited area available for the power house. The site adjoins the Regent's Canal, from which circulating water will be taken, and will be returned to the Canal at a point 100 yards on the down lock side of the intake.

In this generating station sufficient plant is installed to deal with the passenger lifts at Essex Road and Moorgate Street stations, and the lighting of the system, as well as the pure traction load.

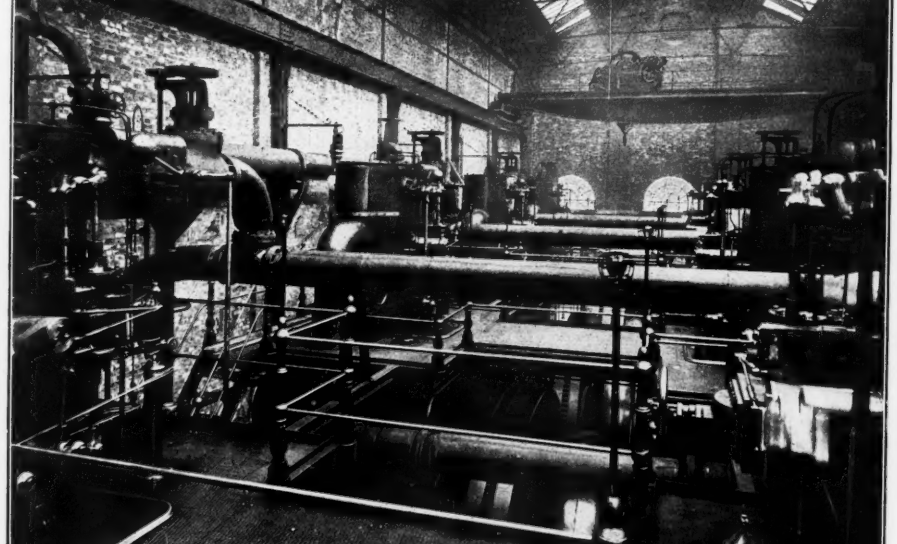
The steam is supplied by 10 "Economic" boilers made by Messrs. Davey, Paxman & Co., Ltd., of Colchester; each boiler is 14 ft. 6 in. long, and 9 ft. 9 in. in diameter, with two flues, each 3 ft. 2 in. in diameter inside. The boiler is made of Siemens-Martin steel, the shell being $\frac{15}{16}$ in. thick, with end plates $\frac{7}{8}$ in. thick; the flues are made with Adamson expansion joints, and there are two cross-tubes in each flue. The return tubes number 138, $3\frac{1}{4}$ in. diameter outside. The grate area is 40 sq. ft., and the heating surface 1,890 sq. ft., giving an evaporative capacity of 11,200 lbs. of water per hour from and at 212° F. with coal of 13,500 B.Th.U. per lb.

It is worthy of note that boilers of the same type are used on two out of the three tube railways at present working in London—namely, the City and South London and the Waterloo and City undertakings.

The whole of the boilers are fitted with Vicars mechanical stokers, driven by shafting in the ash tunnel beneath the floor. Two B.T.H. motors are provided to drive the shafting, and are so arranged that either motor alone can drive both lines of shafting.

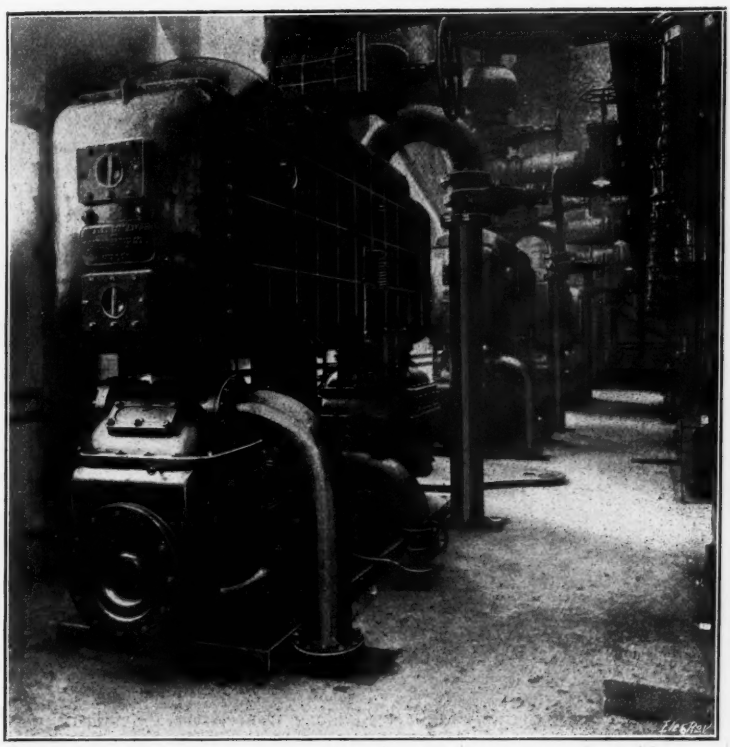
Coal is brought to the works in barges, from which it is lifted by an electric crane to an Avery weighing hopper in an iron tower on the wharf; a coal-filler in the upper part of the tower delivers the coal to a Hunt gravity bucket conveyor, which is capable of handling 30 tons per hour. The conveyor, which is driven by a B.T.H. motor, carries the coal up into bunkers of 800 tons capacity, whence it gravitates as required to the shoots feeding the hoppers of the mechanical stokers. The latter are not refilled until they are practically empty, and as each hopper is known to hold about 4 cwt. of coal, the number of refills affords a rough check upon the coal consumption.

Beneath the stoking floor are hoppers, midway between the boilers, and receiving the ashes from both sides; the conveyor travels beneath the hoppers on its return to the coal tower, and is used to remove the ashes at intervals to the latter. Here they are stored in an ash bunker, which can be emptied by means of shoots into barges.



View of Engines from Switchboard Gallery.

The arrangement of the steam piping is of interest, on account of the confined space available; the main range forms a complete ring, which is horizontal in the boiler house and vertical in the engine room. A separate steam ring supplies the auxiliary plant and feed pumps.



Wheeler Condensers.

The products of combustion pass from the boilers into flues on either side of the boiler house, which convey them through two Green economisers, of 240 tubes each, to the chimney; the latter is situated at about the centre of the site, and is 220 ft. high, 10 ft. in diameter inside. Between the economisers, and at the foot of the chimney shaft, there is a space which may be utilised hereafter for flue-fired superheaters. It will be noticed that the steam generating plant can be divided into halves, either of which can be used entirely independently of the other, and with equal efficiency.

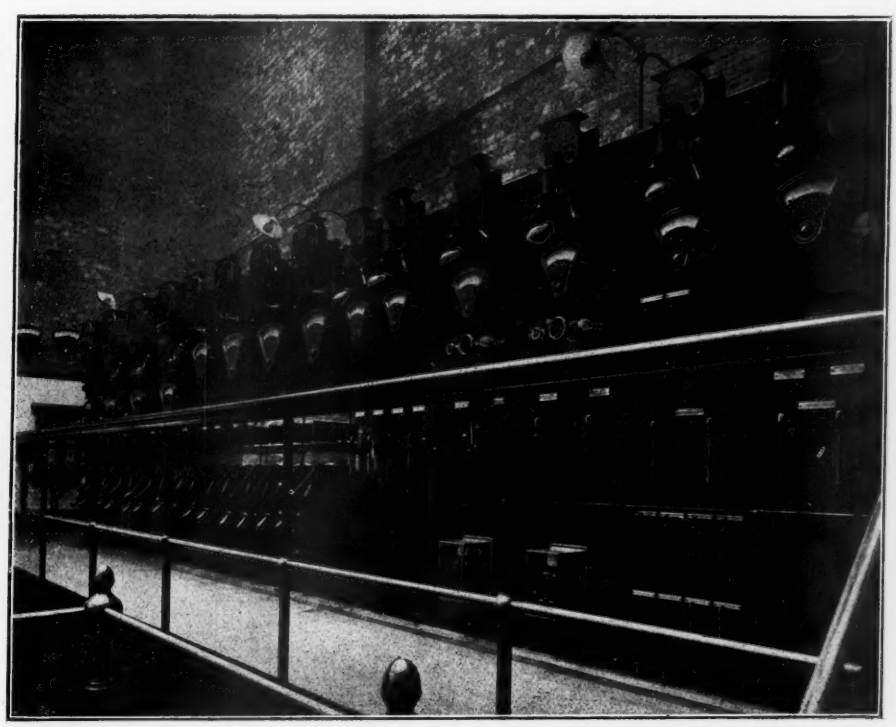
Water for boiler feeding is derived from the canal: an alternative supply can be obtained from the City mains, through a large storage tank in connection with the latter. As the canal water is, to put it mildly, dirty, and varies in hardness—as also does the City supply—a Desrumaux softener and purifier has been installed at the back of the boiler house, capable of treating 8,500 gallons per hour. The softening process is automatically stopped and started as necessary, by means of a mechanical connection with the storage tank, so that a continuous supply of softened and purified water is obtained. In order to utilise the condensed steam for boiler feed-water, a Masson-Scott plant has been provided, in which the oily water is first chemically treated and afterwards filtered, yielding a clear effluent, which is quite suitable for boiler feeding. Three vertical direct-acting duplex steam pumps are installed for the latter purpose, made by Messrs. F. Pearn & Co. The exhaust from these is led either into a Wheeler feed-water heater or into a Wheeler "Admiralty" surface condenser combined with steam-driven air and circulating pumps. This condenser serves also for dealing with the exhaust steam from the auxiliary sets. The pumps, feed-water heater, and auxiliary condenser are situated in a room adjoining the chimney shaft and close to one of the economisers.

The scrapers of the economisers are driven by B.T.H. motors.

Two three-throw vertical lift pumps of the Blake-Knowles type, driven by B.T.H. enclosed motors, deliver the water of condensation from the hot well to the oil separator.

The engine room is lofty and well lighted from the roof and side walls, and is traversed by a 30-ton three-motor electric crane, made by Messrs. Booth and Bros., of Rodley, with B.T.H. motors. The switchboard is mounted on a gallery at one end of the room, commanding a view of the top platforms of all the engines, while at the other end there is a bay level with the outside ground level, and considerably below the engine-room floor.

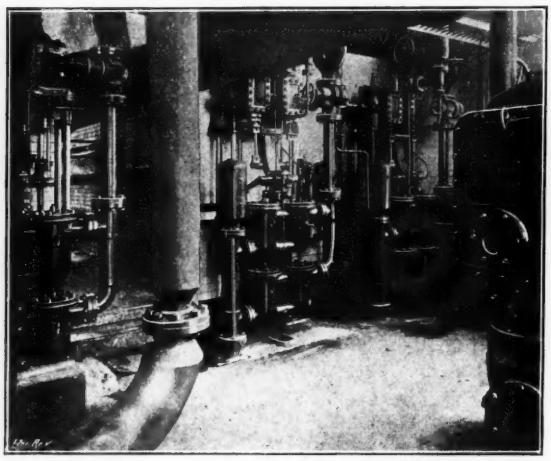
The main generating plant consists of four vertical cross-compound engines made by Messrs. John Musgrave & Sons, of Bolton, driving direct standard railway generators supplied by the British Thomson-Houston Co., Ltd., of Rugby. Each



Main Switchboard.

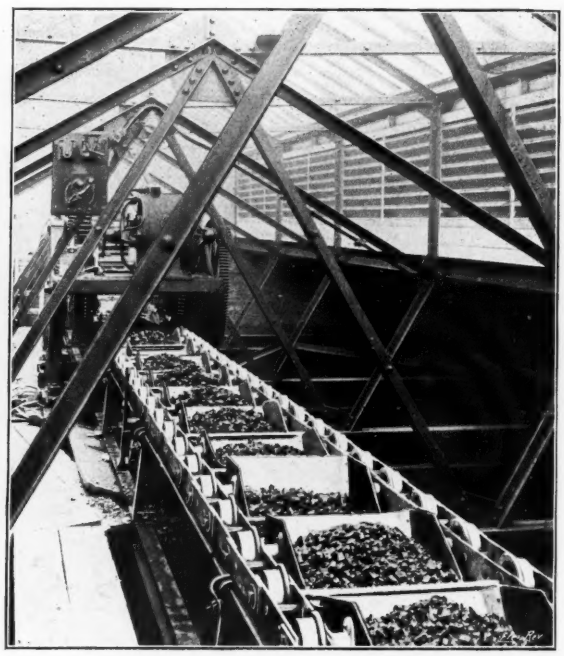
set has a normal rating of 800 KW., but is capable of taking a load of 1,200 KW. for two hours at any time without overheating, and a momentary load of 1,600 KW. without injurious sparking.

The engines are of massive construction, and are fitted with eight-armed fly-wheels, 19 ft. in diameter, and weighing 45 tons each. The valve-gear is of the Corliss



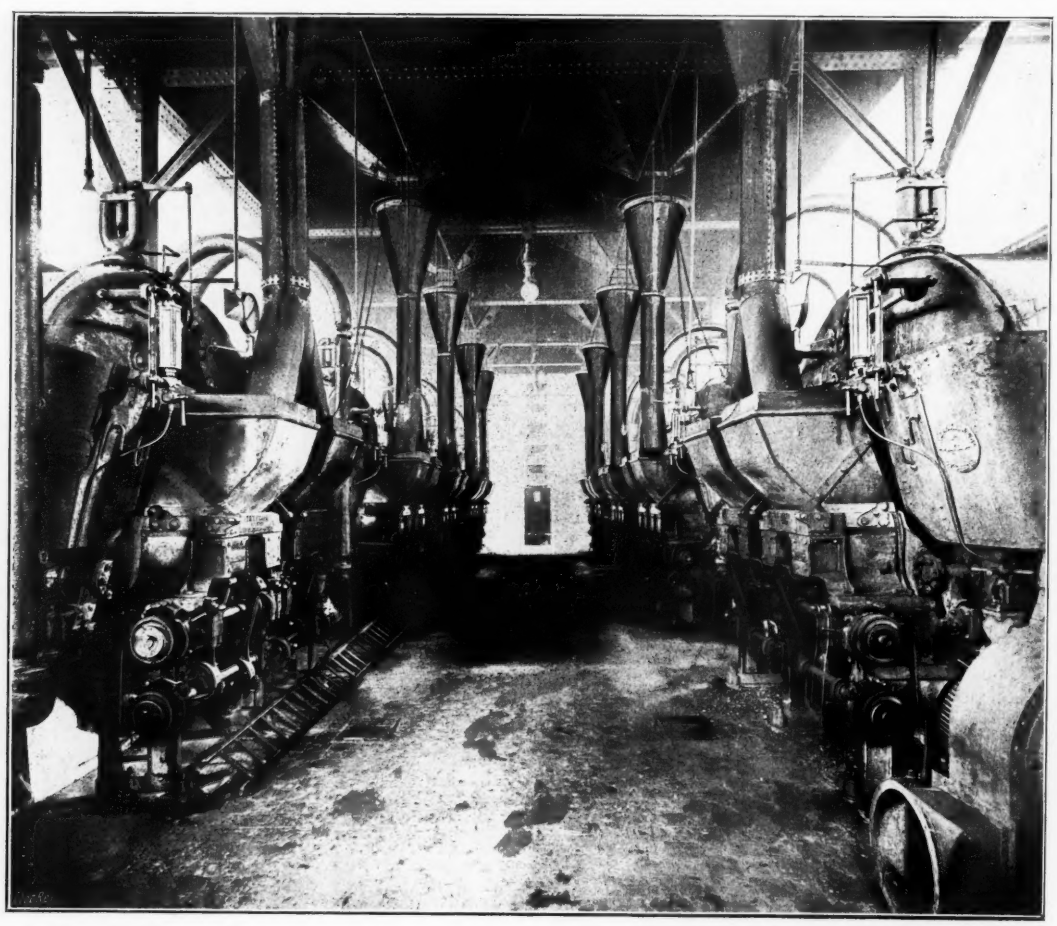
Boiler Feed Pumps, &c.

type, as designed by Messrs. Musgrave & Sons, with automatic cut-off gear on both cylinders. Forced lubrication to all parts is provided by means of duplicate plunger pumps on each bed-plate, and the crank chambers are enclosed. The cross-head is guided on one side only, with flat slides. The exhaust steam from the high-pressure cylinder passes through to join the exhaust pipe from the low-pressure cylinder, and suitable stop valves are provided, so that the high-pressure



Coal Conveyor.

engine can be used alone if necessary. Similarly, a connection is made from the high-pressure steam pipe through



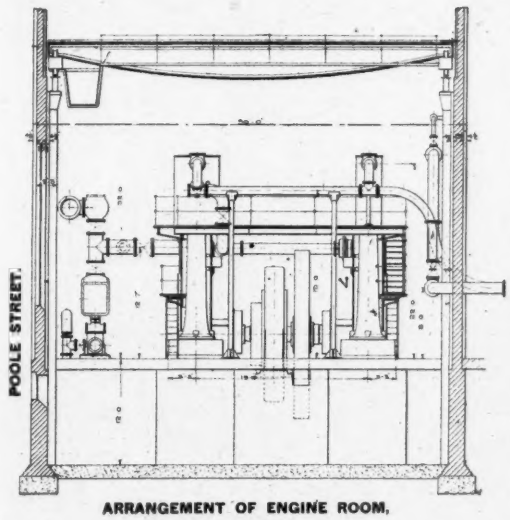
"Economic" Boilers with Vicars Stokers.

a re-heater receiver, heated by live steam, before entering the low-pressure cylinder; the connecting pipe is continued a reducing valve, to the low-pressure admission, so that the low-pressure cylinder can be used alone in case of need.

This connection also provides a means of starting the engine when the high-pressure crank is on a dead centre. The engine runs at 100 r.p.m., under the control of a vertical centrifugal governor, with a normal steam pressure of 150 lbs. per sq. in.

A Holden & Brooke steam separator is provided under each branch from the main range to the engines. The atmospheric exhaust pipe is carried round the engine room and up the outside of the chimney shaft to clear the top of the buildings, and an automatic valve is provided in the exhaust pipe from each engine.

The generators are com-



ARRANGEMENT OF ENGINE ROOM, END ELEVATION.

THE GREAT NORTHERN AND CITY RAILWAY.

10 5 0 10 20
SCALE OF FEET

PLAN OF POWER STATION.

pound wound to give 525 volts at no load, and 575 volts at full load; they consist of heavy cast-iron frames, each carrying 14 poles, with laminated pole faces, and drum-wound armatures, with ample provision for ventilation, keyed on the main shaft.

The generating sets are fixed very close together, on account of the limitations of the site. Near each engine is a Wheeler "Admiralty" condenser, with its own steam-driven air and circulating pumps; each condenser has a cooling surface of 2,400 sq. ft., and is capable of maintaining a vacuum of 26 in. of mercury when dealing with 2,200 lbs. of steam per hour. The equalising switches for the series winding of the generators are mounted on pedestals near the respective machines.

The auxiliary generating sets are two in number, and are fixed in a small room off the main engine room. Each set consists of a Peache engine, made by Messrs. Davey, Paxman & Co., coupled to a British Thomson-Houston generator, running at 375 r.p.m., and rated at 120 KW. The engines are of the three-crank single-acting tandem compound type, with cylinders 11 and 15 in. in diameter, and 10 in. stroke, and are rated at 170 B.H.P. normal full load, and up to 262 B.H.P. on overload. The generators are of the compound-wound six-pole type, giving the same pressure as the main generators, and are capable of carrying an overload of 50 per cent. for two hours. They are intended to supply energy for lighting and power in the power station, and in the railway stations, and to be run when the load is too small to call for the large generators.

The main switchboard is of the standard B.T.H. type, consisting of 16 panels; four of these are for the main generators, four for the feeders, two for the auxiliary generators, and three each for auxiliary power and lighting purposes.

The panels are fitted with B.T.H. circuit-breakers of the M.K. and M.L. magnetic blow-out types, and measuring instruments of the Thomson astatic illuminated dial and feeder types. The switches are of the usual chopper type, with spring break. Provision is made for separating the auxiliary bus-bars entirely from the main bus-bars when running the trains, so that the power station, railway station and tunnel lighting will be supplied from a source entirely independent of the power supply to the trains. Separate paper-insulated and lead-covered cables are used for traction, lighting and lifts; these run from the switchboard along the outside of the boiler-house wall, and then down a special cable shaft into the tunnel.

(To be continued.)

CONTRACTS OPEN.

(*Continued from page* 178.)

Manchester.—March 1st. The Manchester Dock and Warehouse Extension Co. wants tenders for 25 electric hoists and 10 electric fixed cranes. See "Official Notices" to-day.

May-Oatway Installations.—The May-Oatway Fire Appliances, Ltd., invites tenders for installations of its system at Govan and Dundee. See "Official Notices" January 22nd.

May-Oatway Installations.—February 3rd. Tenders for wiring certain installations on this system at Glasgow. See "Official Notices" to-day.

Rochdale.—January 30th. Electric lighting alterations at the Workhouse. See "Official Notices" January 15th.

South Shields.—March 12th. The Corporation invites offers for the lease of certain tramways. See "Official Notices" January 15th.

Spain.—February 12th. Concession for an electric tramway between Porrino and Mondariz (Pontevedra province). See "Contracts Open" December 18th.

Spain.—February 15th. The Public Harbour authorities at Barcelona are inviting tenders until February 15th for the contract for the establishment of the plant and equipment for the electric lighting of the sheds at the Port of Barcelonnette, and for the operation of the cranes, travellers, &c.

Stockport.—February 4th. Fuel economiser. See "Official Notices" to-day.

Sunderland.—February 26th. Crane and battery. See "Official Notices" to-day.

Swindon.—February 15th. Electric wiring of a school. See "Official Notices" to-day.

West Ham.—February 11th. Stores, cable, recording wattmeters, cut-out boxes, transformers, incandescent lamps, and coal for the electricity department. See "Official Notices" January 22nd.

CLOSED.

Brighton.—The Town Council received the following tenders for the supply of the materials for the Dyke Road tramways:—

Section 1.—Steel Poles.

John Spencer, Ltd.	£931	F. Bird & Co.	£988
Stewarts & Lloyd	969	Wilsons & Union Tube Co.	1,002
Dick, Kerr & Co.	980		

Together with several others. The Council decided to accept the tender of Messrs. Stewarts & Lloyd.

Section 2.—Trolley Wire.

F. Smith & Co.	£325	W. F. Dennis & Co.	£330
H. D. Boret	328	Brit. Ins. and Helsby Cables	330
G. Schultz & Co.	330	St. Helens Cable Co.	332

Together with several others. The Council decided to accept the tender of Messrs. F. Smith & Co.

Section 3.—Bases and Section Pillars.

Rowland Carr & Co.	£313	G. Hill & Co.	£341
W. Lucy & Co.	313	Dick, Kerr & Co.	351
J. Needham & Sons	330	J. Spencer & Co.	351

Together with several others. The Council decided to accept the tender of Messrs. Rowland Carr & Co.

Section 4.—Cast-Iron Fittings.

J. Needham & Sons	£42	G. Hill & Co.	£53
R. W. Blackwell & Co.	44	Dick, Kerr & Co.	53
J. Monk	47	Rowland Carr & Co.	53
Railway & Gen. Eng. Co.	51		

Together with several others. The Council decided to accept the tender of Messrs. Needham & Sons.

Section 5.—Pole Brackets.

Dick, Kerr & Co.	£173	G. Hill & Co.	£233
R. W. Blackwell & Co.	193	J. Russell & Sons	266
J. Spencer	226	B. C. Barton	282

Together with several others. The Council decided to accept the tender of Messrs. Dick, Kerr & Co.

Section 6.—Line Fittings.

W. Wood & Co.	£97	Brit. Ins. and Helsby Cables	£102
Dick, Kerr & Co.	97	T. H. Heywood	102
S. Dixon & Son	98	Brit. Elec. Equipment Co.	110
Estler Bros.	101		

Together with several others. The Council decided to accept the tender of Messrs. W. Wood & Co.

Section 7.—Span Wire.

F. Smith & Co.	£15	Adams Bros.	£16
W. F. Dennis & Co.	16	Reed & Sons	17

Together with several others. The Council decided to accept the tender of Messrs. Smith & Co.

Section 8.—Switchboards.

W. Wood & Co.	£38	J. G. Statter & Co.	£58
W. J. Fryer & Co.	44	Estler Bros.	58
S. Dixon & Sons	45	G. Hill & Co.	62

Together with several others. The Council decided to accept the tender of Messrs. W. Wood & Co.

Section 9.—Feeder Cables.

Brit. Ins. and Helsby Cables	£3,209	Callender's Cable and Construction Co.	£3,494
Siemens Bros. & Co.	3,389	Johnson & Phillips	3,556
Western Electric Co.	3,413	St. Helens Cable Co.	3,569
W. F. Dennis & Co.	3,456	W. T. Glover & Co.	3,607
Henley's Teleg. Works Co.	3,483		

The Council decided to accept the tender of the British Insulated and Helsby Cables Co.

Section 10.—Bonds.

G. Hill & Co.	£524	Estler Bros.	£608
W. F. Dennis & Co.	535	British Electric Equipment Co.	685
R. W. Blackwell & Co.	580		

The Council decided to accept the tender of Messrs. R. W. Blackwell & Co.

Section 11.—Wood Blocks.

The Acme Wood Flooring Co., Ltd., London (accepted) .. £7,100

Section 12.—Granite Setts.

Messrs. Brooks, Ltd., London (accepted) .. £615

Battersea.—The Lighting Committee of the B.C. has placed an order with the British Thomson-Houston Co. for 200 prepayment meters. The same Committee recommends the acceptance, at £2,327, of the tender of Messrs. Graham, Morton, Ltd., for coal-conveying plant for its generating station.

Felling-on-Tyne.—The U.D.C. has resolved to apply to the L.G.B. for a loan for the construction of a 6-cell dust destructor and buildings. Messrs. Heenan & Froude have secured the contract for this, amounting to approximately £8,699, the consulting engineers being Messrs. Handcock & Dykes.

France.—The French Post and Telegraph authorities have just given out contracts for a quantity of paper-insulated telephone cable, as follows:—La Société des Cables Electriques, Lyons, 25 kilometres of cable having 28 pairs of conductors; La Société Alsacienne des Constructions Mecaniques, of Belfort, 15 kilometres ditto, with 56 pairs of conductors; M. Grammont, of Pont de Cheruy (Isère), 15 kilometres ditto, 15 kilometres with 14 pairs of conductors and 10 kilometres with 21 pairs of conductors.

Kirkcaldy.—The Electricity Department recently gave out a contract for a Browett & Lindley—Laurence, Scott 430-KW. generating set at £2,619.

London.—The following tenders have been received by the London County Council for the supply of four 3,000-KW. three-phase generators for the power station at Greenwich:—

Name.	Price. £	Remarks.
Siemens Bros. & Co., ...	28,385	Not to specification.
Siemens Schuckert Works, Berlin	28,405	Do. do.
International Electrical Engineering Co., London and Liége ..	23,435	Requires auxiliary heavy fly-wheel.
General Electric Co. (1900), Ltd..	24,379	Do. do.
Witting, Eborall & Co.	29,360	Design considered unsatisfactory.
Electric Construction Co.	29,600	Acceptance recommended.
Bruce Peebles & Co.	30,558	—
Brush Electrical Engineering Co.	32,872	—
British Westinghouse Co.	34,985	—
Dick, Kerr & Co.	36,000	—
Richardsons, Westgarth & Co. ..	39,342	—

Netley.—The War Office have placed the order for the storage battery of 115 cells required for the electric lighting of the Royal Victoria Hospital, Netley, with the Hart Accumulator Co., Ltd.

Southend.—The T.C. has accepted the tender of Mr. J. C. Flaxman, for the extensions to the car-shed at the tramway depôt, at £2,647.

Walthamstow.—The U.D.C. received the following tenders for tramways:—

Contractor.	A Permanent way. £	B Electric Plant, &c. £	C Cables. £	D Overhead Equipment. £
W. Griffiths & Co.	59,914	—	7,221	9,740
J. A. Ewart	58,627	—	—	—
Henley's (*accepted for A, C, D*)	57,700	21,500	7,343	10,883
G. Law..	81,058	—	—	—
R. W. Blackwell & Co.	64,042	—	—	9,522
W. Manders	59,629	—	—	9,522
Acme Wood Flooring Co.	63,994	—	—	—
A. Fasey & Son	67,994	—	—	—
Bruce Peebles & Co.	—	20,861	—	—
Lancashire Dynamo & Motor Co., Ltd.	—	22,685	—	—
Johnson & Phillips..	—	21,700	6,825	—
F. Suter & Co. (*accepted for B*)	—	20,685	7,255	9,048
Mather & Platt	—	21,919	—	—
Electric Construction Co.	—	21,921	—	—
W. T. Glover & Co..	—	—	8,101	—
Siemens Bros. & Co., Ltd.	—	—	7,127	—
Western Electric Co.	—	—	7,143	—
St. Helens Cable Co.	—	—	7,676	—
G. Hill & Co..	—	—	—	10,793
Brush Electrical Engineering Co. ..	—	—	—	9,610
British Thomson-Houston Co.	—	—	—	9,281
Callender's Cable Co.	59,567	—	7,039	11,189
J. G. White & Co., Ltd.	59,739	—	7,339	9,446
Ditto.	—	21,990	—	—
National Electric Construction Co. ..	—	22,221	—	13,173
Dick, Kerr & Co., Ltd.	57,700	—	7,343	10,883
Torque E.E. Co.	—	22,000	—	—
Macartney, McElroy & Co.	55,040	—	7,659	10,245
British Insulated & Helsby Cables, Ltd.	—	—	6,947	9,945
W. Underwood	60,476	—	7,959	11,092
International E.E. Co.	—	20,620	—	—
Engineer's Estimates	75,693	25,000	18,480	15,890

Woolwich.—The War Office authorities have placed with Messrs. Reavell & Co., Ltd., of Ipswich, an order for a 250-c.f. electrically-driven air compressor, of their special direct coupled type, for Woolwich Arsenal.

FORTHCOMING EVENTS.

Friday, January 29th.—At 8 p.m. Institution of Civil Engineers (Students). "Metallurgy as Applied in Engineering," by Mr. A. P. Head.

At 8 p.m. Institution of Mechanical Engineers. Discussion to be resumed on "Sixth Report to the Alloys Research Committee on the Heat Treatment and Steel," by the late Sir Wm. C. Roberts-Austen, completed by Prof. Wm. Gowland.

Saturday, January 30th.—At 8 p.m. Bohemian concert of the Electrical Engineers R.E. Vols., at headquarters, Regency Street, S.W.

Tuesday, February 2nd.—At 8 p.m. Faraday Society. Meeting at I.E.E. Papers on "Notes on Aluminium Welding," by Mr. S. Cowper-Coles, and "Some Applications of the Theory of Electrolysis to the Separation of Metals from one Another," by Mr. A. Hollard.

At 7.30 p.m. Institution of Electrical Engineers (Manchester). Mr. W. Chilton on "Steam Turbines."

At 6 p.m. London Electrical Contractors' Association. Meeting at Holborn Restaurant. "On the Rights and Liabilities of Electrical Contractors under the Electric Lighting and other Acts," by Mr. R. Tweedy Smith.

Wednesday, February 3rd.—At 8 p.m. Society of Arts. "Steam Cars for Public Service," by Mr. T. Clarkson.

At 2.30 p.m. Institution of Civil Engineers. Students' visit to Plumstead Electricity and Destructor Station.

Thursday, February 4th.—At 8 p.m. Civil and Mechanical Engineers' Society. "General Notes on the London Traffic Problem," by Mr. J. F. G. Reynolds.

At 8.30 p.m. Röntgen Society. Discussion on "Production of Photographic Reversal through the Action of various Radiations."

Friday, February 5th.—At 8 p.m. Junior Institution of Engineers. "Producer Gas Power for Factories, Cold Stores, and Freezing Works," by Mr. H. Williams.

Saturday, February 6th.—Institution of Electrical Engineers (Glasgow). Annual Smoking Concert at Grand Hotel.

At 7.30 p.m. Glasgow Technical College Scientific Society. Twelfth Anniversary Dinner.

NOTES.

A Visit to the Crossley Gas Engine Works.—In a recent issue the announcement was briefly made that Messrs. Crossley Bros., Ltd., the well-known gas engine builders, had taken up the construction of petrol motors and motor-cars. On Friday last week a small party of pressmen were invited to Openshaw, Manchester, to inspect the first motor-car turned out, and also to go over these large works. Needless to say, the car in question, while following what may be termed standard lines, is of the highest grade of construction. The motor is of the four-cylinder vertical type, nominally rated at 22-H.P., but developing 30 B.H.P. at 1,000 r.p.m. As this is practically the first occasion on which the Press has been invited to the Crossley Works, a few particulars of the extent of the enterprise and its operations may be of interest. The works cover an area of between 10 and 12 acres, and give employment to from 1,200 to 1,400 men. The foundries turn out about 180 tons of steel and iron castings per week in addition to 3 tons of brass and gun-metal. The forge department produces about 15 tons of cranks and 4 tons of small forgings per working week. The weekly output of gas engines, ranging from the smallest size up to 700 H.P., is 80, or at the rate of one every 45 minutes. No less than 800 engines are always in course of construction, while a stock of 200 finished engines is usually kept on hand. The works are driven by a large number of gas engines, aggregating 1,000 H.P.; they work with producer gas, the cost of fuel working out at the low rate of ·08d. per B.H.P. per hour. The progress of the Crossley works is shown by the fact, that whilst in 1894, the output amounted to 21,600 B.H.P., last year a total of 48,900 B.H.P. was attained. During the last seven years £80,000 has been spent in extensions and in replacing old machinery with modern tools, while a further expenditure of £30,000 in a similar direction is in contemplation. As the writer passed through the works, he noted a 25-H.P. gas engine and dynamo mounted on a common baseplate intended for the L. & N. W. Ry. Co., for use at St. Helens Junction, and a number of engines for Russia. Considerable interest was displayed in a 700-H.P. engine shown in operation; this has two cylinders set on each side of the central crankshaft, the cylinders being 32 in. diameter × 36 in. stroke, the normal speed being 140 r.p.m. This is the largest engine so far turned out by Messrs. Crossley; it is one of four they have on order for shipment to the United States. The capacity of the works was also indicated to the visitors by the casting of the half of a 30-ton fly-wheel, an operation which was successfully carried through.

London County Council.—At the meeting on Tuesday, it was decided to advance £2,883 to the Stepney Borough Council for electric lighting purposes.

The Parliamentary Committee announced that it had been found necessary to deposit a memorial complaining of non-compliance with Standing Orders in the case of the London United Tramways (Railways) Bill, which seeks to connect the company's systems north and south of the Thames, and to establish a direct communication between these tramways and the Metropolitan District Railway at Hammersmith Broadway. The connection is proposed to be effected by means of a line, the greater portion of which will be in London, to be constructed partly in tube under the river, partly in tunnel, and for a short distance on the surface. The route is in part under the County Council's authorised line from Hammersmith Broadway to the northern end of Hammersmith Bridge, and the proposed railway would be connected with a tramway which is purchasable by the Council in 1909. In the opinion of the Committee the lines appeared to be tramways or tramroads, and the Bill required the consent of the Council as the local authority to its introduction, and in these circumstances the memorial had been lodged.

Approval was given to plans submitted by the Bermondsey Borough Council for the erection of additions to the generating station in Spa Road.

Municipal and County Club.—Sir Francis J. S. Hopwood, K.C.B., C.M.G. (Permanent Secretary to the Board of Trade), will be the guest of the evening at a house dinner and smoking concert, to be held on Monday, February 8th, at 7.30 p.m. Mr. Laurance Gomme, F.S.A. (Clerk to the London County Council) will preside.

The Treatment of Cancer by Physico-Therapeutics.—The following conclusions were stated in a paper sent to the National Academy of Medicine by Dr. J. A. Rivière, of Paris:—

1. Our practice in physico-therapeutics, dating from our communication to the International Congress of Medical Electrology and Radiology (Physico-Therapeutical Treatment of Malignant Tumours) for the cure of neoplasms, must be regarded, by modern medicine, as a very useful method for effecting the diminution of the tumours, the relief of the painful symptoms, and the disappearance of the ganglionic congestions.

2. The physico-therapeutical method is the only one to be used in the case of certain neoplasms that either cannot be operated upon, or that are doomed to be rapidly reproduced; in vegetating ulcerous and terebrating forms, and cases of epithelioma; in cases of sarcoma and carcinoma reappearing after surgical intervention.

3. We employ, in preference, radio-therapeutics, static currents, and currents of high frequency, without neglecting the ordinary physico-therapeutic methods (static baths, d'Arsonvalisation, &c.), and also calomel and quinine administered internally to encourage eliminations and the neutralisation of neoplastic elements, which are set in motion by the local treatment, and tend to return to the circulation.

4. The most striking effects of our physico-therapeutical treatment are: the disappearance of swellings, congestions and indurations, the cessation of darting and other pains, the rapid and complete cicatrisation of the rodent ulcer, the subsidence and shrivelling up of the spreading off-shoots; lastly, the complete disappearance of cachexia and wasting, and the return to a good general condition of health.

5. Although operations are frequently successful in the cure of re-appearing tumours, it is preferable to treat neoplasms by this method when they first appear. Radio-therapeutics will always act upon the whole of the diseased area, for histology shows that the neoplasm always extends further than the apparent seat of injury.

6. Notwithstanding the well-known rapid improvement (the subsidence of pain, the contraction of the foci, the checking of adeno-pathic proliferations), it is indispensable that treatment by physical methods should be persevered in, especially as regards the continuation of the methods for improving the diathesis generally.

7. We think we are justified in asserting before this Society that the treatment of malignant growths has entered upon a new phase, in virtue of the modern physico-therapeutic methods. The facility, simplicity, painlessness and promptitude of our modes of treatment, the wonderful uniformity of the results obtained, the complete recovery of the functions involved, all give to physico-therapeutics an incontestable curative value, both as regards the number of cures and the reality of the improvement obtained in cases (both new and recurring) that had seemed beyond the resources of medical art.

Carbide Factories in Italy.—The Societa Italiana del Carburo di Calcio, of Rome, which is the owner of the carbide works at Terni, has recently opened another factory of 5,000 H.P., at Sebenico, in Dalmatia, the energy being derived from a power station situated on a fall on the River Kerka about 7·5 miles distant. The same company is also the proprietor of a generating station of some 7,000 H.P. at Javuza on the left bank of the Kerka, where the plant is divided into two units of 3,500 H.P. each. About 5,000 tons of calcium carbide are being made annually at Javuza. Work has also been started at Manojlavac, where another factory is eventually to be erected. The River Kerka has four waterfalls, at Boljan, Manojlavac, Rosniak, and Milijacka respectively, from which the Italian company hopes to obtain 25,000 H.P., so that in about two years' time it will be able to produce over 30,000 tons of carbide per annum. The capital invested in these enterprises is stated to be 8 million lire.

Electric Motor Vehicles on the Continent.—The Electrischer Kraftwagenbetrieb mit Oberleitung fur da Verschedethal Gesellschaft is the name of a company which has been formed at Pilstein to establish and work a service of electric motor vehicles, taking their current from overhead conductors, between Kirchveischede and Grevenbrück, Germany.

Application has been made to the authorities of the Canton of Ticino for a concession to establish and work a public service of electric motor vehicles between Locarno and Gravellona, Switzerland.

Illuminating Power of Gas.—It is announced that the President of the Board of Trade has appointed the following gentlemen, viz:—

Lord Rayleigh, F.R.S. (Chairman),
Sir William de W. Abney, K.C.B., F.R.S.,
Dr. Robert Farquharson, M.P.,
Mr. William King,
Mr. J. Fletcher Moulton, K.C., M.P.,

to be a committee to inquire and report as to the statutory requirements relating to the illuminating power and purity of gas supplied by the metropolitan gas companies, and as to the methods now adopted for testing the same, and whether any alteration is desirable in such requirements or methods, and, if so, whether any consequential alteration should be made in the standard price of gas. Mr. Herbert C. Honey, of the Board of Trade, has been appointed secretary to the committee.

Lectures.—At the Dundee Institute of Engineers on 14th inst., Mr. Harry Richardson, the city electrical engineer, of Dundee, lectured on the use of electricity for lighting and power.

At the Camera Club on Monday night, Dr. George W. Rodman delivered an important lecture on "Photography of Some Electrical Discharges."

Tramway Accident Claim.—In the King's Bench Division on Tuesday Mr. Justice Grantham and a special jury awarded Mr. Phillips and his wife £2,500 damages and £430 expenses against the London General Omnibus Co. and the London United Tramways Co. Plaintiffs were riding on a 'bus at Chiswick when it was run into by an electric tramcar and overturned, and plaintiffs sustained severe injuries.

Röntgen Rays and Tumours.—The *Comptes Rendus*, January 11th, has a note by M. de Courmelle on radiotherapy as a means of diagnostic and therapeutic in certain fibromes. It is believed that certain abdominal tumours, notably fibromes, may degenerate into carcinomes, and he applied X rays to two patients suffering from fibromes, who did not wish to undergo an operation. Their aspect made him suppose that a malignant tumour might result in future. His experience of the treatment by the Röntgen rays, while he does not allow it to draw him into premature conclusions, makes him think that they may be useful in cases of painful tumours when an operation is feared. The patients were aged 47 and 41 years. One had a very large tumour on the stomach, the other a tumour as big as an egg. The rays were applied for 15 minutes at a distance of 20 cm. from the skin. The tube was of the kind known as "hard," and the spark 30 cm. long. A plate of aluminium connected to earth was interposed between the tumour and the tube. After each application the patients felt contractions in the morbid region, and the tumours gradually softened and lessened. After 27 applications the patient with the larger tumour, which is now small, has recovered his health. The other tumour, big as an egg, has resisted more, but whilst the former case had applications every day for 10 days, then thrice a week, the latter had them thrice a week all the time. Still, it has diminished to half its size, and the patient's general state of health is now good.

I.E.E. (Birmingham).—Members of this section visited the West Bromwich electricity works, Black Lane, on Wednesday, January 27th.

Sir Frederick Bramwell's Will.—The estate of the late Sir Frederick Bramwell is valued at £109,798, including £91,956 net personality.

Northampton Institute.—Lord Kelvin will present the certificates and prizes at the Annual Prize Distribution and Conversazione on February 26th next.

Appointment Vacant.—Shift engineer for the Stretford Electricity Works (38s.).

London Electrical Contractors' Association.—We are informed that the paper by Mr. Tweedy Smith, announced in our "Forthcoming Events" to-day, promises to create considerable interest, as he has unearthed numerous instances of supply companies making demands in which they are unjustified. Supply companies' engineers are invited to attend.

A Triumph of Intellect.—According to the Berlin correspondent of the *Evening Standard* (21st inst.):—"The general management of the Swiss Federal Railways has under consideration a new form of electric heating for locomotives, in which there is said to be no waste of thermic energy, such as occurs when a coal furnace is used. The alterations required in ordinary locomotives would include the reconstruction of the boiler and the substitution of the electric heating apparatus for firebox and boiler tubes. The electric current is obtained from a running trolley, the only extra appliances on the driver's stand plate being switches for controlling the current. The main advantage claimed for the electro-thermic method is the trifling cost of reconstruction, the easy instruction of the drivers, and the retention of existing methods of heating the cars, applying breaks (*sic*), &c."

We are utterly at a loss to adequately express our appreciation of this beautiful invention. So simple, yet so perfect!

Personal.—Mr. Percy P. Gutteridge, accountant for the Mid-Yorkshire Tramways (now being operated by Messrs. J. G. White & Co., Ltd., of London), has been appointed chief clerk to the City of Gloucester light railways. Mr. Gutteridge has acted as accountant for Messrs. J. G. White & Co., Ltd., on several of their tramway undertakings, including the Shipley sections of the Mid-Yorkshire tramways, Wolverhampton district, Dudley, Stourbridge, &c., and has a wide experience of tramway work generally.

Seventy-two applications have been received by Warrington T.C. for the post of tramways manager. The commencing salary is £120 a year, rising by increments of £10 to £150. Those selected to appear before the Electricity and Tramways Committee are:—Mr. T. Tate, Shipley; Mr. J. Telfer, Rotherham; Mr. C. Womersley, Huddersfield; and Mr. J. Worrall, New Brighton.

We are informed that Mr. E. Rotter, A.M.I.C.E., of 47, Victoria Street, Westminster, and Pearl Buildings, Portsmouth, has taken into partnership Mr. T. Harison Jones. The firm will in future be known as "Rotter & Jones." Mr. Harison Jones has had large experience in tramways, mining and power work in America.

We understand that Mr. T. L. Boyden, who has been for more than nine years chief of the continuous-current dynamo department of the Electric Construction Co., Ltd., of Wolverhampton, has accepted the position of general manager to the Lister Electric Manufacturing Co. Mr. Boyden is taking up his duties forthwith.

We regret to learn that Mr. W. G. McMillan, the secretary of the Institution of Electrical Engineers, is suffering from an attack of pleurisy.

E.E.R.E. Volunteers.—Unveiling a Memorial Tablet.—On Wednesday evening last, the ceremony of unveiling a memorial tablet to the electrical volunteers who gave their lives for their country in the South African war was solemnly performed at the headquarters of the corps. Amongst those present were Col. Pitt, R.E., the officer commanding the corps, Major Crompton, Major Erskine, Mr. R. Kaye Gray (President I.E.E.), and other distinguished gentlemen. Major Crompton briefly introduced Col. Pitt, who said that they met there with mingled feelings of pride and regret. Though their comrades had died of disease—the greatest enemy of the soldier—the corps had had more than its full share of hard fighting, and was especially distinguished at Leeuw Spruit, where the men fought as well as the best. The corps had to go before the army and perform difficult and dangerous duties, on which the success of the army might depend, and always acquitted itself with great credit. The men were so successful that detachment after detachment had to be sent out, and a larger proportion of the corps went to the front than in the case of any other volunteer corps. Of all sappers, the Electrical Volunteers were the handiest—they could tackle any engineering work whatever. Col. Pitt regretted that Dr. John Hopkinson had not lived to see the success of the movement which he had inaugurated. Col. Pitt then briefly sketched the record of the detachments which went out, numbering 319 men in all, and referred to the distinctions gained.

The tablet was then unveiled, while the Volunteers presented arms, and the "Last Post" was sounded. Major Erskine afterwards thanked Col. Pitt for attending as officer commanding, and Col. Pitt briefly responded. The tablet bore the following inscription:—

The Electrical Engineers.

In Memory of

2nd Corporal A. Holdaway,
Sapper E. C. Short,
" F. C. Weakley,
" E. J. West,
" F. Kelly-White,
" C. H. Richardson,
" S. Foxcroft,
" J. P. Allen.

Who Died on Active Service,

South Africa,

1900—1901—1902.

Glasgow Section of the I.E.E.—On Saturday, the 13th, an extraordinary meeting of the section will be held in Edinburgh, detailed announcements of which will be made later. The afternoon will be spent by the members visiting the new works of Messrs. Bruce Peebles & Co., and in the evening a paper will be read by Mr. Georgi upon "Coal-Cutting Machinery," &c.

THE CENTRAL STATION ENGINEER.

No fewer than 69 applications were received for the post of general manager of the Bolton Corporation Tramways, and on January 20th the Tramways Committee selected Mr. A. A. DAY, borough electrical engineer, for the post. Mr. C. C. HOWARD was appointed traffic superintendent at a salary of £250 per annum.

By the casting vote of the Mayor, Chester T.C. has increased the salary of the borough electrical engineer, Mr. F. THURSFIELD, to £550 a year, rising by £50 a year to £700.

The Electricity Department of the Harrogate Corporation held their second annual dinner on Friday evening, 22nd inst., Mr. G. Wilkinson, borough electrical engineer, presiding. The chairman proposed "The Corporation of Harrogate," which was replied to by Mr. Councillor Davidson, the chairman of the Electric Light Committee, in a very interesting and able manner. The toast of the Department was proposed by Mr. Councillor Davidson; and Mr. McLean of the Works staff, and Mr. Court of the town, replied. A smoking concert followed.

NEW COMPANIES REGISTERED.

Armorduct Manufacturing Co., Ltd. (79,791).—This company was registered on January 20th, with a capital of £10,000 in £5 shares, to acquire and take over as going concerns the business of electrical engineers, merchants, agents for and dealers in all kinds of electrical apparatus, appliances and accessories, &c., now carried on by W. Schmahl at London, Newcastle-on-Tyne, and elsewhere as "Atkinson, Schmahl & Co." and the "Armorduct Improved Electric Conduit Co.," and to carry on the same and the business of electricians, mechanical engineers, producers, workers, and suppliers of electricity, manufacturers of conduits, bare and insulated wires and cables, &c. The first subscribers (each with one share) are:—W. Schmahl, 3, St. Nicholas Buildings, Newcastle-on-Tyne, electrical merchant; Mrs. I. Schmahl, 12, Edwards Road, Whitley Bay; R. Burdis, 43, St. Aidans Street, Gateshead, clerk; Mrs. L. Robson, 9, Akenside Terrace, Newcastle-on-Tyne; Mrs. E. Robson, Dane Cottage, Chilham, Kent; A. G. Robson, 8, Eldon Square, Newcastle-on-Tyne, electrical merchant; and F. Emley, Mosley Chambers, 89, Mosley Street, Newcastle-on-Tyne, solicitor. No initial public issue. The number of directors is not to be less than two nor more than five; the first are W. Schmahl, A. Lynen and A. G. Robson; qualification, £1,000; remuneration (except governing director), two guineas per meeting; W. Schmahl is governing director, and may retain office for 30 years; remuneration, £500 per annum and 10 per cent. of the net profits. Registered office, 6, Farringdon Avenue, E.C.

Brecknell, Munro & Rogers, Ltd. (79,763).—This company was registered on January 18th, with a capital of £30,000 in 2,000 preference shares of £5 each and 20,000 ordinary shares of £1 each, to acquire the business of electrical and mechanical engineers, founders and brass-finishers, now carried on at Thrissell Street and Jacob Street, St. Philip, both in Bristol, as Brecknell, Munro & Rogers, to adopt four agreements—(1) with H. Brecknell, E. M. Munro, and H. I. Rogers, (2) with H. Brecknell, (3) with E. M. Munro, and (4) with H. I. Rogers—and to carry on the said business and that of manufacturers of agricultural implements and other machinery, tool makers, millwrights, machinists, iron and steel converters, smiths, wood-workers, builders, painters, metallurgists, electricians, water supply engineers, gas makers, &c. The first subscribers are:—H. Becknell, Thrissell Street, Bristol, founder and engineer, one preference share; E. M. Munro, Thrissell Street, Bristol, founder and engineer, one preference share; H. I. Rogers, Thrissell Street, Bristol, founder and engineer, one preference share; H. E. F. Brecknell, 330, Fishponds Road, Bristol, foundry manager, one ordinary share; A. H. Trotman, Torquay Villa, Whitehall Road, Bristol, accountant, one ordinary share; W. S. A Brown, 49, Corn Street, Bristol, solicitor; and W. H. Brown, 49, Corn Street, Bristol, solicitor, one ordinary share. No initial public issue. The number of directors is not to be less than three nor more than five; the first are H. Brecknell, E. M. Munro and H. I. Rogers (joint managing directors); qualification, £500; remuneration as fixed by the company. Registered office, Thrissell Street, Bristol.

ELECTRIC TRAMWAY ACCOUNTS.

Sunderland and Birkenhead Municipal Tramways.

WE give herewith a comparison of the working results of the Sunderland and Birkenhead tramway undertakings, both of which reflect credit on their management.

The northern borough is the more prosperous and populous, and with its shorter mileage obtains receipts above the average per car-mile.

Birkenhead, however, has an advantage in the matter of working expenses per car-mile, the smaller item for energy derived from its own power station largely contributing to this result. The borough possesses two tramways power stations, having capacities of 300 and 1,175 KW. respectively, while at Sunderland energy is purchased from the lighting department.

In both undertakings a considerable net balance remains after meeting financial obligations.

In the case of Sunderland, Mr. H. England occupied the position of general manager during the period under review; while at Birkenhead Mr. A. R. Fearnley occupied a similar position.

GENERAL STATEMENT.

	Sunderland.	Birkenhead.
For 12 months ending	March 31, 1903	—
Length of route	9·92 miles	13·52 miles
Total length of track	18·48 miles	23·53 miles
Number of cars in use	64	60
Car-miles run	1,270,957	1,279,087
Passengers carried per annum ...	13,987,121	10,390,985
Capital expended to date	£258,451	£346,058
Traffic receipts	£59,142	£51,078
Total "	£59,930	£52,876
Working expenses	£34,066	£30,367
Gross profit	£25,864	£22,509
Income per car-mile	11·31d.	9·90d.
Working expenses per car-mile ...	6·43d.	5·69d.
Interest & sinking fund per car-mile	3·80d.*	3·54d.
Total expenses per car-mile... ...	10·23d.	9·23d.
Profit or loss per car-mile	1·08d.	·67d.
Cost of energy per car-mile	2·1d.	1·16d.
Average fare per passenger... ...	1·03d.	1·2d.
Revenue per mile of route	£5,993	£3,917
Expenditure per mile of route ...	£3,406	£2,250
Total units used	1,335,660	1,953,095
Units used per car-mile	1·05	1·53
P'rcn'tage of working ex'es to receipts	57%	57%

* Includes also depreciation.

PROFIT STATEMENT.

	Sunderland.	Birkenhead.
To interest on loans	£7,820	£10,869
To sinking fund and depreciation account	12,311	*8,042
To balance...	5,733	3,598
Gross profit ...	£25,864	£22,509

* Sinking fund only.

After meeting financial charges, the balances were disposed of as follows:—In the case of Sunderland, £5,000 was carried forward in aid of the rates, and the balance divided between the Accident and Coronation fund accounts, and legal and Parliamentary expenses. The Birkenhead balance was carried to the renewals account, which now amounts to £7,113.

CITY NOTES.

City and South London Railway Co.

THE directors' report for the half-year ending December 31st, 1903, to be submitted to the meeting on February 2nd shows that the receipts from all sources amounted to £75,811, and the cost of

working to £36,284, leaving a profit of £39,527. Including the balance brought forward, the net revenue account shows an aggregate total of £41,027. After making provision for the debenture stock interest, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £28,296. The directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896 and 1901, and that a dividend at the rate of 2 per cent. per annum be paid upon the consolidated ordinary stock for half-year, leaving a balance of £746 to be carried forward. The following table shows the course of business during the past 4½ years:—

	Number of passengers (exclusive of season ticket holders).	Receipts (including season tickets).	Dividend per cent. per annum on ordinary stock.
December 31st, 1899	3,442,942	£26,198	1½
June 30th, 1900	4,169,717	33,608	1½
December 31st, 1900	5,018,842	44,716	1½
June 30th, 1901	5,893,786	51,014	1½
December 31st, 1901	7,008,842	59,735	2½
June 30th, 1902	9,192,120	76,844	3
December 31st, 1902	9,877,199	82,131	3½
June 30th, 1903	9,511,450	78,385	2½
December 31st, 1903	8,711,062	72,286	2

The totals since the opening of the line are:—Passengers, 117,080,281; receipts, £928,524.

Railway opened for traffic December 18th, 1890.
Extension to Moorgate opened February 25th, 1900.
Extension to Clapham Common opened June 3rd, 1900.
Extension to Islington opened November 17th, 1901.

The directors express regret that the receipts during the half-year show so considerable a decrease as compared with the corresponding period last year, but it must be borne in mind the receipts during that period were abnormally increased owing to the interruption of the tramways while under re-construction for electric working, and also to the increased traffic due to the ceremonies in connection with the Coronation. Apart from these sources of revenue, the general traffic of the line has been maintained, and is slowly but steadily recovering from the competition of the electric tramways. It has been found necessary to reduce the fares over some portion of the line; also to popularise the issue of season tickets both by reducing their cost and issuing them for shorter periods. The company expects to benefit from the opening of the Great Northern and City Railway in February. The negotiations are proceeding with the various railways interested as to the nature of the works and other arrangements in connection with the extension to King's Cross, St. Pancras and Euston. When these are settled, the directors will have to consider the best mode and the most opportune time for raising the necessary capital.

Great Northern and City Railway.

The report for the half-year ended December 31st, 1903, states that the railway between Moorgate Street and Finsbury Park is now practically completed, and for some time past a service of trains has been running experimentally almost daily. The line will be opened for public traffic between those two points when the necessary certificate from the Board of Trade has been obtained. The underground work for the new station at Highbury is well advanced, and the extension from Moorgate Street to the Bank at Lothbury will be proceeded with as soon as possible. The sanction of the proprietors will be asked for a Bill in the next session of Parliament, which merely seeks for an extension of time for the completion of a small portion of the line at the south end of Moorgate Street Station. A train will be in readiness at Moorgate Street Station to convey shareholders attending the meeting to Finsbury Park Station and back.

Blackpool and Fleetwood Tramroad Co.

The half-yearly report shows that the balance, after providing for debenture interest, is £10,677, and the directors recommend a dividend at the rate of 9 per cent. per annum, which will absorb £6,750, to write off £1,500 to depreciation reserve, place £500 to a special reserve account, and carry forward a balance of £1,927. During the half-year 1,469,964 passengers were carried, and the receipts from all sources amounted to £21,404.

Marconi International Marine Communication Co.

The report for the year ended June 30th last has only just been issued, and it is to be presented at the meeting on 2nd prox. It states that the chief efforts of the board have been directed towards obtaining a permanent basis for profitable business in the future, and a very considerable further extension of the operations of the company has resulted. This extension has been principally in connection with the equipment of further ships, the coast stations mentioned as available for communication in last year's report having served for a great part of this increased shipping traffic. Preparations have, however, been made for a wireless service on new routes other than the Atlantic, and to this end nine new coast stations have already been equipped, and there are on order 14 further coast stations. The opening of these stations will, it is thought, result in profitable contracts with lines of ships voyaging on these routes. In particular, is mentioned a contract now practically concluded, relating to the equipment of a whole fleet taking the Mediterranean route. Other important ship contracts are in negotiation. The stations which have been erected, or are in course of erection, by this company and its associated companies, which include, also Lloyd's stations, over which this company has exclusive rights for wireless telegraph purposes for 14 years from September 26th, 1901, number 54. An arrangement has recently been made with Reuter's News Agency for the regular transmission through the company's stations to vessels fitted with the Marconi system of Press telegrams. Even at the present time the company is deriving a considerable profit from this business, although the range of transmission has been limited. When the latest and highly successful results obtained by Mr. Marconi in his long-distance experiments are applied to coast stations, and a daily wireless news service can be maintained throughout the Atlantic voyage, this branch of its business will, it is confidently anticipated, prove a very large source of revenue. An agreement has recently been concluded with the Government of Newfoundland for the installation of a number of stations on the coasts of Newfoundland and Labrador, which will be begun in the spring. These stations will be available for ships equipped with the Marconi apparatus. Mr. Marconi has been busily engaged throughout the year in perfecting apparatus for long-distance communications, and for the purpose of testing improvements in the apparatus, and as a demonstration to independent persons of its capabilities, in his voyage across the Atlantic in August on board the *Lucania*, and in a voyage of H.M.S. *Duncan* to Gibraltar in October, messages were transmitted to the ships throughout their passages. The profit and loss account shows a debit for the year of £14,960.

Manx Electric Railway Co.

The report of the directors from August 18th, 1902, to September 30th, 1903, shows that the gross receipts amounted to £41,300, and the gross expenditure to £20,435, making the net earnings £20,865. The following had to be deducted:—Debenture interest and interest on mortgage, £8,863; profit earned before incorporation, placed to capital account, £4,005; preference dividend, 5½ per cent., £4,732; leaving a balance of £3,266 to be carried forward. The accounts cover a period of one year and six weeks. The gross takings during the extra six weeks in August and September, 1902, were £9,605, which, in the ordinary course, would have been credited to a separate year. Profits, however, earned during the period antecedent to the incorporation of the company, *i.e.*, from August 18th to November 12th, 1902, may not in any case be treated as revenue, and have accordingly been placed to the credit of capital account. The balance of £3,266 the directors propose to carry forward. During the past year new works have been undertaken upon capital account, the total expenditure upon which will amount to £49,239 7s. 2d., made up as follows:—

New plant and equipment	£44,398	15	8
New retaining wall and permanent way at Bulgham Bay	3,332	7	0
Purchase Dhoon Quarry	1,508	4	6
	£49,239	7	2

The directors desire to point out that hardly any advantage has yet been actually gained from this expenditure, the works having been barely completed at the end of the summer season; but next year, the increased power and rolling stock, and more economical working may be expected to yield a satisfactory return upon the outlay.

The company has 22½ miles of line, and the miles run during the above period were:—Passengers, 448,632; goods, 39,237.

The auditors point out in their certificate that no provision has been made for depreciation of plant, machinery, or other property.

A general meeting of the shareholders of this company was held on Tuesday, at the offices, 78, Cornhill, Mr. Ernest Schenk presiding in the absence through indisposition of the chairman, Mr. A. G. Kitching.

The Chairman, in proposing the adoption of the report, said that the period covered by the accounts embraced one year and six weeks. The gross receipts had amounted to £41,300, and the gross expenditure to £20,434, leaving a net profit of £20,865. As that was the first year's working, he thought they would look upon it as highly satisfactory, inasmuch as the working expenses for the period were a trifle under 50 per cent. He felt bound, however, to point out that the extra six weeks covered a very good season of the year—the autumn, during which their traffics were high, and one could hardly expect the expenses always to work out quite as low proportionately as they had last year. They proposed to allocate the balance as follows:—£8,862 to debenture interest and mortgage; £4,731 10s. to pay 5½ per cent. interest on the preference shares; £4,005 having been earned before the date of the incorporation of the company, they were not allowed to distribute it in dividends, and it had been placed to capital account, which left a balance of £3,265, which they proposed to carry forward. That balance, he would point out, was equal to about 3½ per cent. on the ordinary shares. During the year they had undertaken works on capital account involving expenditure amounting to just under £50,000. The bulk of that money would be spent in plant and equipment. At the end of December last the capital account stood at £104,900, and it was very unlikely that they would issue any further substantial amount of capital unless they undertook developments or extensions which were not at present under consideration. They had, however, overdrawn the account by about £5,000, which they were setting right by a further issue of debenture stock. He would remind them that the line was taken over by the company in consequence of the liquidation of Dumbell's Bank, and not quite so much had been spent upon it as they had expended since it came into their hands. It was satisfactory to note that the total capitalisation, including the new expenditure, was actually less than the original cost of the line, and inasmuch as the track was almost entirely freehold, and where not so, they had perpetual running powers; that they had undoubtedly the best route in the island, and

were quite safe from competition of any kind; they might be quite satisfied that they had a valuable property, likely to increase in value as years went on. They had erected large power works at Laxey, where they would get increased power at a lower cost of production. They had provided accommodation for general goods and cattle traffic, and they believed they could secure a very considerable amount of such traffic. Generally, their prospects were most favourable. Of course, the success of their company depended upon the popularity of the island as a holiday resort, and the new Governor, Lord Raglan, was doing everything he could to further popularise the Isle of Man in that respect.

Mr. BERNARD E. GREENWELL seconded the motion, and the report was adopted.

Eastern Telegraph Co.

THE report for the half-year ended September 30th states that the revenue amounted to £565,703, from which are deducted £169,232 for the ordinary expenses and £48,004 for expenditure relating to repairs and renewals of cables, depreciation of spare cable, sundry differences in exchange, and income-tax payable abroad, leaving a balance of £349,466, to which is added £5,031 brought forward. After making provision for income-tax payable in England, interest on loan from Eastern and South African Telegraph Co., Ltd., interest on mortgage debenture stock, and for two quarterly dividends on the preference stock, which in all absorb £94,630, there remains a balance of £259,867, from which is allocated £7,000 to the reserve fund for maintenance ships, £120,000 to the general reserve fund, and £100,000 to meet the two interim dividends of 1½ per cent. each on the ordinary stock for the quarters ended June 30th and September 30th respectively, the balance of £32,867 being carried forward.

Sir J. WOLFE BARRY presided at the meeting held on Wednesday at River Plate House. He said that the gross revenue for the half-year amounted to £566,000, or a decrease of £17,000. The decrease in the net receipts for messages was £35,500, but this was reduced to a total decrease of only £17,000 by various *per contra* items. The reduction in the message receipts was principally in the Cape Joint-Purse, the Australian and the China, Japan and Manila traffics, those branches alone showing a decrease of £63,000. Although the traffic with Australia showed a considerable falling off, due to the unfair and unstinted competition of the British Goverment Pacific cable, they were holding their ground as far as it was possible to do so under these adverse conditions. The Eastern Extension Co.'s revenue on this account was more seriously affected than that of this company. He still held the view that the policy of establishing State-aided competition with a commercial undertaking was an unsound policy. It had proved, in this case, unprofitable to the State, and a most serious, almost fatal, discouragement to commercial cable enterprise. The establishment of this Government cable could only be justified on stragetic or imperial grounds, and not, as it had, in spite of promises to the contrary, become, as an active and unfair competitor (supported by public moneys and the official support of the British and Colonial Governments) with British commercial interests. These interests should, in the speaker's opinion, be considered identical with the interests of the Empire and should not be opposed with taxpayers' money. It was surely an anomaly that they should be obliged to contend against British as well as foreign subsidised cables at a time when so much was being said as to the necessity of encouraging British and Colonial enterprise on account of foreign competition. The large decrease under the head of China, Japan and Manila traffic resulted principally from the opening of the Commercial Pacific cable and the large reduction made in tariff referred to at the general meeting in July last. As a part set-off against the above-mentioned decrease in traffic receipts, improvements appear in the Indian, Egyptian, and Turkish traffic, and a substantial increase in that for Aden, resulting from the very heavy Government and Press traffic arising out of the trouble in Somaliland. The gross revenue this half-year included £15,300 for interest on reserve fund investments, against which, on the other side of the account, has been charged the interest on the loan from the Eastern and South African Telegraph Co., amounting to £13,100, making a small difference in favour of revenue of £2,200. After explaining certain proposed alterations in the forms of arranging the accounts with respect to interest and reserve funds appropriations, Sir John said that the ordinary expenses for the half-year amounted to £168,000, or an increase of £11,000. Of this increase, £2,700 is in the general expenses in London, while the working expenses at stations have increased to the extent of £8,400. The principal increase was some £5,600 in salaries and wages, due to annual promotions and to the fact that the staff on September 30th, 1903, numbered 84 more than at September 30th, 1902. The other items of expenditure, with two or three exceptions, showed small increases when compared with 1902, these being due to the extension of the system, and to the special contributions to some of the subsidiary reserve funds. The expenses attending maintenance of cables, including depreciation of spare cable, amounted to £47,500, against £77,000 in 1902, showing a most satisfactory decrease of £29,500. This was, however, an item over which the executive had little or no control, and the reduced expenditure was almost entirely due to the fact that a much smaller quantity of cable had been expended than in the corresponding period of 1902, in addition to which the receipts arising from the hire of their ships to others for cable-repairing purposes showed an increase of £10,000 compared with 1902. The sum they had invested in other telegraph companies amounted to £1,461,277. As a result of the half-year's working, they were able, after providing for debenture interest and the usual quarterly dividends on the preference and ordinary stock, to carry £7,000 to maintenance ships reserve, £120,000 to general reserve, and to carry forward a balance of nearly £33,000 to the next half-year, against about £22,000 carried forward in the corresponding period of 1902. During the half-year they had repaid £100,000 to the Eastern and South African Telegraph Co. on account of the loan, of which £650,000 was still outstanding, and they had applied a similar amount from the reserve fund to the reduction of the expenditure on account of new cables. Mr. A. R. Hardie, who had previously occupied the position of accountant to the company, had been appointed secretary in succession to Mr. George Draper, who had retired after long service.

Sir J. D. PENDER seconded the adoption of the report, and it was carried.

Charing Cross and Strand Electricity Supply Corporation.

THE directors' report for the year ended December 31st, 1903, says that they are again able to report satisfactory results of the year's trading in both their West End and City areas of supply.

The West End Undertakings.—Notwithstanding the fact that several large premises to which supply has hitherto been given have been demolished in connection with the County Council and other improvements, the number of lamps added is 55,326, exceeding by nearly 21,000 lamps the number added in 1902. The total mains now laid amount to 221 miles. The revenue from sales of current for 1903 amount to £110,083. The balance of the net revenue account is £53,890. £14,000 was distributed as interim dividend at the rate of 8 per cent. for the half-year ended June 30th, 1903. There remains a sum of £39,890, which the directors propose to deal with as follows:—

Dividend on 4½ per cent. preference shares apportioned to December 31st, 1903	£15,750	0	
Dividend at the rate of 12 per cent. for the half-year ended December 31st, 1903, on ordinary shares, making, with the interim dividend paid in August, 1903, 10 per cent. for the whole year	21,000	0	0
And to carry forward	3,140	4	2
	£39,890	4	2

City Undertaking.—The distributing station buildings in Beech Street, Barbican, have been completed, and machinery is being installed there. The total mains now laid amount to 215 miles. There have been connected up to the City mains during the past year 91,384 additional 8 C.P. lamps, making, with 150,729 lamps connected at December, 1902, a total of 242,113 lamps. The progress of the business has more than realised the expectation of the directors. The gross revenue from sales of current during the year amounted to £56,036, or over 100 per cent. more than the gross revenue obtained in 1902. The net revenue account shows a profit of £11,499. The 4½ per cent. preference dividend to December 31st, 1903, guaranteed by the Corporation's West End undertakings has been paid.

The extension of the company's business renders it necessary to increase its capital, and an extraordinary general meeting authorising this will be held at the conclusion of the annual meeting on Wednesday, February 3rd.

STATEMENT OF ELECTRICITY GENERATED, SOLD, &c.

Quantity generated or bought in B.T. units.	Quantity sold.			Quantity used on works.	Total quantity accounted for.	Quantity not accounted for.	Number of public lamps.	Total maximum supply demanded.
	Public lamps.	Other sales.	Total sold.					
West End undertaking:—								kw.
10,527,639	293,104	7,099,687	7,392,791	2,757,527	10,150,318	377,321	113	4,284
City undertaking:—								
7,274,568	—	5,033,880	5,033,880	1,961,080	6,994,960	279,608	—	5,712

Direct United States Cable Co.

MR. E. M. UNDERDOWN, K.C., presided at Tuesday's meeting of this company, at Winchester House. He moved the adoption of the report abstracted in our last issue, and in regard to the figures there given he said that there was a falling off in the revenue, but that did not arise from anything peculiar to this company, it was due to the general torpidity of business. Their traffics were always an index to the activity of business, and they could not but expect that a falling off of business would take place when the business which was generally transacted between this country and the United States showed a reduction of from 10 to 12 per cent. They would hope that it should be only temporary, and take consolation from the fact that all their friends had suffered from the same reason. The working expenses had been practically the same. The cost of the heavy repairs to the main section of the cable had been put against the reserve fund, and they continued to make up that fund by the steady application of reasonable amounts. During the half year Mr. H. C. B. Underdown (the speaker's son) had been on a visit to the company's stations in the United States, Canada, and Nova Scotia, and found everything in perfect order. He had drawn up a valuable report on various matters of importance. After referring in a befitting manner to the loss sustained by the company in the death of Admiral Sir Henry Keppel—whose seat they did not propose to fill at present—the resolution was seconded by Sir James Pender.

After a few questions had been answered the report was adopted and the meeting closed with the usual vote of thanks.

Dublin United Tramways Co. (1896), Ltd.

The report for the half-year ended December 31st last, together with the accounts of the Dublin United (Old) and the Dublin Southern District Companies, states that the amount available for division is £48,950, out of which dividend for the half-year are recommended at the rate of 6 per cent. per annum on the preference shares and at the rate of 6 per cent. per annum on the ordinary shares. A sum of £4,000 has been placed to credit of reserve fund, £2,000 to maintenance during the current half-year, and £1,000 to an accident insurance fund.

Metropolitan Railway Co.

The report for the half-year ended December 31st last, says that the receipts show an increase of £12,347, and the expenses a decrease of £1,197. The work of electrification is being proceeded with rapidly by the company's engineering staff. The building of the power station at Neasden is practically completed and ready for the reception of the machinery, which is being constructed at the works of the British Westinghouse Electric and Manufacturing Co. The new reservoir adjoining the power station is filled, and the wells continue to show an ample supply of water. The building of the necessary sub-stations and the equipment of the permanent way are proceeding. A Bill is being introduced into Parliament in the coming session in which powers are sought to convert and consolidate the company's debenture and preference stocks, and to raise additional capital to the extent of £750,000, with the usual borrowing powers, mainly for the purpose of paying for the electrical equipment of the line. The passengers carried totalled 94,000,150, an increase of 4,125,317.

Charing Cross and Strand Electricity Supply Corporation.—The directors recommend a dividend on the ordinary shares for the half-year ended December 31st, 1903, at the rate of 12 per cent. per annum, making, with the interim dividend already distributed, 10 per cent. for the year 1903.

South London Electric Supply Corporation.—The company reports having sold during the quarter ended Christmas last 2,009,230 units, realising £18,230. The figures for the corresponding quarter in 1902 were 379,167 units, realising £7,412.

Central London Railway Co.—The dividend for the past half-year is at the rate of 4 per cent. per annum on the ordinary, preferred and deferred stocks, the sum of £10,000 being placed to reserve and £36,000 carried forward. A year ago the dividends were the same, with £10,000 to reserve and £27,717 carried forward.

South Wales Electrical Power Distribution Co.—An extraordinary meeting of this company was held at the offices of the company last Friday. A resolution was passed authorising the creation and issue of £50,000, part of the £250,000 debenture stock which the company is empowered to issue under the provisions of their Act of 1900.

Stock Exchange Notice.—The Committee has ordered the following to be officially quoted:—Kalgoorlie Electric Power and Lighting Corporation, Ltd.—150,000 6 per cent. cumulative preferred shares of £1 each, fully paid, Nos. 1 to 150,000.

Prospectus.—The *British Electric Traction Co.* is inviting applications until to-day of £250,000 4½ per cent. second debenture stock at par. The issue is offered by the Electric and General Investment Co. The money is required for the general business of the company, which is engaged in actual constructional operations in London, and many provincial districts in connection with its numerous electric tramway and light railway systems.

Liverpool Overhead Railway Co.—The accounts for the past half-year show an available balance of £10,882, and the directors have resolved to recommend payment of a dividend at the rate of 5 per cent. per annum on the preference shares, and 1½ per cent. per annum on the ordinary shares, against 1¼ per cent. per annum on the ordinary shares for the corresponding period last year. Balance carried forward £4,132.

Westminster Electric Supply Corporation.—The Board recommends a dividend at the rate of 14 per cent. per annum for the half-year ended December 31st, 1903, making, with the interim dividend, 13½ per cent. for the year.

STOCKS AND SHARES.

Wednesday Evening.

Here and there around the Stock Exchange markets may be found some of the members complaining less than usual about the sparseness of business. Not that there is any real revival, of course—the political horizon provides a very substantial damper to that—but investment orders on a somewhat better scale are quietly coming in, and the departments comprising electrical securities feel the benefit of such attention already. The awfully dramatic tragedy of Tuesday has, of course, influenced the markets not a whit, although only some three years since the movements of certain West Australian shares governed by the hand of the dead financier used to indirectly affect—and powerfully affect—a wide range of stocks and shares far removed from their own immediate circle.

Central London Railway Ordinary stock has risen sharply upon the declaration of 4 per cent. dividend on all three classes of Ordinary stocks. This distribution is in accordance with the final market estimate to which we referred last week. The dealers are short of stock, and there appear to be very few sellers about at the current quotation; the Deferred stock naturally looks cheaper now that it carries an actually declared dividend of 4 points in its price, bringing it down to practically 88½. The nominal price of 91—94 is the same as that quoted for Waterloo and City Stock. City and South London was but little affected by the issue of the report, which forms a useful homily upon the danger of taking shares in a company that in one brief period does remarkably well by reason of adventitious causes. The little City line did a fine business in 1902, but as the report remarks, a good slice of the prosperity was due to the dislocation of road traffic caused by the laying down of the County Council trams, to say nothing of the additional traffic brought by the Coronation. Now, the board's hopes are largely based upon the prospects of securing good results from the company's extensions towards the north of London.

Of the electricity supply shares, County of London Ordinary have improved ½ to 8½ on the dividend outlook, while Charing Cross at 9 are unchanged now that the accustomed rate, making 10 per cent. for the year, is announced. The Preference shares, however, have hardened 5s. Smithfields are ¼ up at 3½, and South Londons have added a similar fraction at 3⅜, the former in tardy recognition of the advance of 1½ per cent. in the dividend. The only declines in this section befell Edmundson Ordinary and Preference, due to the offer of £100,000 in £5 Preference shares of 6 per cent., which existing holders of both classes have the option of taking, *pro rata*, at £5 10s. per share. Manifestly the shareholders should not let this opportunity slip for acquiring the shares cheaply; the fall in the old is due to the regular precautions taken by the market against sales by proprietors who want money wherewith to pay for their allotments of new Preferences. Metropolitans are nominally unchanged at 17½. Blackheath and Greenwich maintain their last week's improvement, and the Preference are quoted at 1¼ middle. Kensington and Knightbridge Debenture supply almost the only change in the gilt-edged list by advancing a point to 103½.

New issues are a good deal to the fore at the moment, and the Henley's Telegraph Works is raising more capital by the offer of 5,000 Ordinary shares at £10 apiece, and 5,000 Preference at £5. The Ordinary are called about 10s. premium in the market, but should be worth considerably more, seeing that the old shares stand at 13½, a fall of 10s. on the week. After allowing for the advantages that the old will have for a few months over the others, the margin between the two sets is unreasonably wide, and is caused by shareholders being in a great hurry to realise what they would be much better advised to take up as an investment. Telegraph Constructions are back again at 34½, having lost their £1 rise of last week. Callenders slipped down to 11, a fall of 10s., otherwise the miscellaneous section is quiet.

Lively bidding for the National Telephone varieties has left four of them slightly better. A dealer started bidding for them one morning, and took one issue after another in quick succession, his efforts being reflected in the enhanced prices. Anglo-American Ordinary and Preferred stocks have each gained a point; the Deferred at 8 is ¼ to the good. Indo-Europeans are a pound harder; the shares seldom come to market, and a small inquiry suffices to put the price up. Of the Eastern descriptions, a 1 per cent. rise to 89½ in Eastern 3½ per cent. Preference is the only quotable alteration. The Marconi report makes interesting reading, and the pioneer work still being done causes the addition to the debit balance to be no more than natural. The price of the shares is dullish at about 27s. 6d.

Another offer of stock by the British Electric Traction Co., takes the shape of £250,000 4½ per cent. Second Debenture stock at par. The issue is guaranteed by the Electric and General Investment Co. The prospectus explains that the expansion of the British Electric Traction's business necessitates the raising of more capital, and it also states that £2,897,380 worth of shares has been issued, not to mention £1,300,000 First Debenture stock. British Columbia Electric Deferred is being done at 79½, and Brisbane Electric First Debenture changed hands the other day at 97½. London United Preference are 11½, and other traction shares are so steady as to call for no especial comment.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 20th.	Closing Quotations Jan. 27th.	Business done week ended Jan. 27th, 1904. Highest	Lowest
£ 67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	98 —102	98 —102	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2⅛— 3⅛	2⅛— 3⅛	3⅛	3
119,700	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	.. — ..	..	..
788,840	Anglo-American Telegraph	Stock	6½.	6/6	..	49 — 52	50 — 53	50½	..
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	..	94 — 96	96 — 97	96½	95
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	..	7⅞— 8	7⅞— 8⅛	8 5/16	8
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4⅜— 5⅛	4⅜— 5⅛	4⅝	..
13,333,300 $	Commercial Cable	$100	8 %	8 %	..	175 —185	180 —190	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	88 — 92	88 — 92	91⅞	90½
16,000	Cuba Telegraph	10	4 %	6½%	..	7 — 8	7 — 8	7⅞	..
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	..	2⅜— 3⅛	2⅜— 3⅛	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7⅛— 8⅛	7⅛— 8⅛	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	98 —101%	98 —101%	..	..
60,710	Direct United States Cable	20	3¼%	3¼%	..	10 — 10½	10 — 10½	10 1/16	..
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	119 —124 xd	119 —124	121½	120
1,955,555	Do. 3½ % Pref. Stock	100	..	..	..	87 — 90 xd	88 — 91	90	88
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	105⅛	..
300,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	..	10½— 11⅛ xd	10½— 11⅛	11 1/16	10½
320,000	Do. 4 % Deb. Stock	Stock	..	..	..	106 —109	106 —109	105	..
300,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 3,000, red. 1909	100	..	..	..	99 —102	99 —102	100⅜	..
200,000	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 3,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	6¼%	..	..	8⅛— 8⅜	8⅛— 8⅜	8 1/16	8⅛
180,042	Do. do. 6 % Pref.	10	..	..	..	12½— 13	12½— 13	12 1/16	..
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	..	24½— 25½	24 — 25	..	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	98 —101	98 —101	..	..
17,000	Indo-European Telegraph	25	10 %	10%	..	37 — 40	38 — 41	39½	..
100,000	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	100 —106	..	..
1,983,333	National Telephone, Pref. Stock	100	5 %	6 %	..	102 —104	102 —104	103½	10⁻½
1,966,667	Do. do. Def. Stock	100	..	4½%	..	77 — 80	78 — 81	80	78½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	..	13 — 14	13½— 14½	14	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	..	13 — 14	13½— 14½	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	..	5 — 5⅛	5⅜— 5⅝	5⅝	5⅛
000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	..	95 — 97	95 — 97	96⅞	96½
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	..	100 —102	100 —102	101⅛	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	..	⅞— 1	⅞— 1	15/16	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	..	..	6⅞— 7⅛	6⅞— 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	118 —123	118 —123	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5⅛— 6	5⅛— 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4⅞— 5⅛	4⅞— 5⅛	..	..
179,947	Do. do. 5 % Debs.	Stock	..	..	..	102 —105	102 —105	..	..
15,609	West African Telegraph, Shares	10	..	2 %	..	5 — 6	5 — 6	..	..
150,000	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	..	..
267,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	..	11⅞— 12⅛	11⅞— 12⅛	12	11 13/16
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	99 —102	99 —102	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	99½	..
88,321	West India and Panama Telegraph	10	..	..	..	⅜— ½	⅜— ½	..	..
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6 — 6½	6 — 6½	6 1/16	6
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	4½— 5½	4½— 5½	..	..
80,000	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	99 —102 xd	99 —102	101	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

£ 20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½— 5½	4½— 5½	..	..
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	87 — 91 xd	87 — 91	..	..
100,000	British Electric Traction	10	9 %	8 %	..	11½— 11⅝	11½— 11⅝	11⅝	11 5/16
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11½— 11⅝	11½— 11⅝	11 5/16	11 5/16
600,000	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	..	..
100,000	British Insulated and Helsby Cables	5	10 %	10 %	..	6 — 6⅛	6 — 6⅛	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅞— 6⅛	5⅞— 6⅛	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —107	102 —107	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	7/16— 1/2	7/16— 1/2	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	..	⅜— 1½	⅜— 1½	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	..	¹⁄₁₆— 1½	1½— 1½	..	..
125,000	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
135,000	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	75 — 80	75 — 80	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	..	11 — 12	10½— 11½	11½	11⅜
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5⅞— 5⅞	5⅞— 5⅞	..	..
90,000	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	91 — 94	94 — 97	97	95⅝
494,093	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	98 —101	98 —101	100⅝	..
494,993	Do. do. Def. do.	Stock	4 %	4 %	4 %	91 — 94	91 — 94	..	..
1,380,000	City and South London Railway	Stock	2 %	3½%	2⅔%	49 — 52	49 — 52	51½	49
85,000	Crompton & Co., Nos. 1 to 85,000	3	7½%	5 %	..	1⅜— 2	1⅜— 2	..	..
100,000	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	97 —100	97 —100	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	5	Nil	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	5	Nil	Nil	..	⅜— 1½	⅜— 1½	..	..
344,023	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	73½	72
100,000	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅝— 1⅞	1⅝— 1⅞	1 11/16	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	..	..	..	2⅜— 3	2⅜— 3	2⅝	..
82,500	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100 xd	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9½— 10	9½— 10	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	95 — 98	95 — 98	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	..	13½— 14½	13 — 14	14½	13⅝
35,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	18 — 19 xd	18 — 19	18⅞	..
300,000	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	4⅞— 5	4⅞— 5	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10½	10 — 10½	..	..
37,350	Telegraph Construction and Maintenance	12	20 %	20 %	..	34 — 37	33 — 36	35	33½
150,000	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	100 —103 xd	100 —103	..	..
540,000	Waterloo & City Railway, Ord. Stock	100	3 %	3⅛%	..	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations Jan. 20th.	Closing Quotations Jan. 27th.	Business done week ended Jan. 27th, 1904. Highest.	Lowest.
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	..	..	..	¾— 1	¾— 1	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	114 —117	114 —117	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	..	10 — 10⅛	10 — 10⅛	..	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	9⅜— 10⅛	9⅜— 10⅛	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	10 %	8⅞— 9⅛	8⅞— 9⅛	9 1/16	8⅞
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅛— 5⅜	5⅛— 6	5 13/16	..
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	4¼— 5	4¼— 5	4⅜	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	103 —105	..	..
44,436	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	..	5⅛— 6	5⅛— 6	5 1/16	5 1/16
150,000£	Do. do. % Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	..	10¼— 10¾	10⅛— 10¾	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	..	..
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	..	7½— 8½	8 — 9	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11½— 12½	11½— 12½	..	..
400,000£	Do. do. 4½% Deb. Stock	..	..	..	..	107 —110	107 —110	108	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	6 — 6⅛ xd	5⅞— 6⅛	6⅛	..
80,000	Do. do. 6 % Cum. Pref.	..	..	..	..	6 — 6⅛	6⅛— 6⅛	6 1/16	5⅞
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	103 —106 xd	104 —106	..	..
21,000	Kensington and Knightsbridge Electric, Ord.	5	10 %	10 %	..	11 — 12	11 — 12	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	101 —104	102 —105	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1⅞— 2⅛	1⅞— 2⅛	..	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	5⅛— 6	5⅛— 6	..	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	97 —100	95 — 98	97	96
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6¾%	7¼%	..	17 — 18	17 — 18	17 1/16	17
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	5 3/16	..
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000£	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	..	12¾— 13½	12¾— 13½	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	14½— 15½	..	..
90,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000£	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	98 —101	98 —101	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3⅜— 3⅝	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1⅜%	..	3½— 3⅝	3⅞— 4	3⅞	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅛— 5⅛	4¼— 5⅛	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅛— 5⅛	4¼— 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	10¾%	12 %	13½%	12½— 13⅝	12⅝— 13⅝	13⅛	12⅝
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6 — 6⅜ xd	6 — 6⅜	6¼	6⅛

*Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, January 27th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a ,, ...	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£13	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£21 10	30/- inc.
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks ..	per lb.	8d.	..
a ,, Caustic (75/80%).. ..	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	226/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a ,, Bichromate, casks.. ..	per lb.	2½d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots ..	per ton	£130	..
b ,, Wire, in ton lots ..	per ton	£168	..
b ,, Sheet, in ton lots ..	per ton	£166	..
p Babbitt's metal ingots	per ton	£43 to £130	..
e Brass (rolled metal 2' to 12') basis	per lb.	7d.	..
e ,, Tube (brazed)	per lb.	9a.	..
e ,, ,, (solid drawn).. ..	per lb.	7½d.	..
e ,, Wire, basis..	per lb.	7½d.	..
e Copper Tubes (brazed)	per lb.	9½d.	..
e ,, ,, (solid drawn) ..	per lb.	9½d.	..
g Copper Bars (best selected ..	per ton	£73	..

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£73	..
g ,, Rod	per ton	£73	..
e ,, (Electrolytic) Bars ..	per ton	£68	..
e ,, ,, Sheets ..	per ton	£78	..
e ,, ,, Rod ..	per ton	£75	..
e ,, ,, H.C. Wire	per lb.	7¾d.	..
f Ebonite Rod	per lb.	8/3	..
f ,, Sheet	per lb.	8/-	..
m German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	4/1½ to 4/3	1½d. inc.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	42/4	5d. dec.
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8 ..	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 17 6 to £12	2/1 dec.
g ,, ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 5	..
d Mica (in original cases) small ..	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large ..	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£129 to £130	£7 10 dec.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7½	½d. dec.
p White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5⅜d.	..
j ,, 3 ply 10 lbs. Russian ..	per lb.	4½d.	..
j ,, 10 lbs. Russian, single ..	per lb.	4½d.	..
j ,, 180 lbs. Jute rove ..	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£24 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Aberdeen	Jan. 23	1,083	+320	31	41,991	+ 7,999	10	—
Birmingham ..	,, 23	5,051	+559	4	20,425	+ 1,683	3½	—
Bournemouth ..	,, 20	840	—	—	—	—	10½	—
Blackburn	,, 15	705	+ 81	—	35,502	+ 1,454	13½	—
Blackpool	Dec. 24	287	— 18	—	37,603	— 159	8½	—
,, —Fleetw'd	Jan. 23	190	+ 27	4	600	— 24	7½	—
,, —Lytham	,, 21	143	+124	12	1,733	+ 1,169	7½	—
Bolton	,, 24	1,612	+ 66	43	78,757	+ 8,686	25	—
Bradford	,, 24	3,404	+544	41	161,242	+21,449	45	—
Brighton	,, 24	689	+ 8	—	39,185	—	7½	—
Bristol	,, 22	4,491	+374	—	—	—	28	—
Devonport ..	,, 15	466	+ 94	2	1,006	+ 125	5	—
Dudley—Sto'rb'ge	,, 15	713	+ 83	2	1,481	+ 6	18½	—
Gateshead ..	,, 15	838	+117	2	1,841	+ 35	10½	+ ½
Gr'n'k—Pt. Glsgw	,, 15	414	+ 88	2	1,013	+ 77	7½	—
Hartlepool ..	,, 15	236	+ 49	2	625	+ 58	6½	+2
Middleton	,, 15	228	+ 14	2	508	— 28	8½	—
Oldham—Ashton	,, 15	471	— 16	2	1,032	— 118	8	—
Potteries	,, 15	1,647	+287	2	3,271	+ 21	28⅔	—
Southport	,, 15	229	+ 33	2	505	+ 20	5½	—
South Staffs. ..	,, 15	736	141	2	1,473	+ 55	21½	— ½
Swansea	,, 15	460	+ 5	2	971	— 43	5½	—
Wolverhampton ..	,, 15	818	+ 20	2	651	— 45	10½	+8
Yorks. Wool Dist.	,, 15	504	—	2	1,093	—	6	—
Miscellaneous ..	,, 15	1,190	—	2	2,551	—	—	—
Burnley	,, 23	822	+178	—	—	—	7½	—
Burton-on-Trent ..	,, 24	270	—	25	8,845	—	8½	—
Cardiff	,, 23	1,779	+294	—	84,183	+21,640	1	—
Chatham & District	,, 21	493	+154	3	1,504	+ 389	8·53	—

* Compared with the corresponding period of 1903.

Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
Cork	Jan. 21	398	+ 19	3	1,210	+ 32	9	—
Dover	,, 23	163	— 7	3	567	— 37	3	—
Dublin	,, 22	4,312	+147	4	13,748	+ 663	47	+ ½
East Ham	,, 23	561	+137	—	28,530	+ 7,933	5	+ ½
Glasgow	,, 23	18,374	+1745	34	465,336	+49,429	69½	+7½
Halifax (2 weeks) ..	,, 13	2,173	+ 72	41	55,826	+ 5,899	31½	+1½
Huddersfield ..	,, 23	1,099	+207	—	—	—	—	—
Hull	,, 23	1,979	+319	43	81,670	+ 5,912	13	+2½
Ilkeston	,, 20	120	—	—	—	—	4	—
Ipswich	,, 23	274	—	—	2,620	—	7·86	—
Isle of Thanet ..	,, 26	198	— 13	3	637	— 19	10½	—
Leeds	,, 23	5,020	+617	—	235,420	+14,817	41	—
Liverpool	,, 16	9,531	+1016	3	28,849	+ 1,330	103	—
London C. C. ..	,, 23	8,906	+1499	42½	421,135	+75 745	39½	—
Manchester	,, 23	10,729	+2822	—	498,974	+271,043	72	—
Newcastle	,, 23	3,441	+526	—	—	—	17	—
Portsmouth	,, 23	1,282	+ 84	—	75,358	+ 4,681	14½	—
Salford	,, 18	3,443	+815	—	160,578	+45,490	30	—
Sheffield	,, 17	4,149	+471	3	12,807	+ 1,009	31½	+4
Southampton ..	Dec. 17	814	+ 17	—	—	—	16½	—
Southend-on-Sea ..	Jan. 13	186	+ 19	41	13,412	+ 2,098	8	—
Sunderland	,, 24	1,024	+ 90	43	52,366	+ 2,526	20	+8
Tyneside	,, 20	2·5	+ 85	3	766	+ 198	8·9	+43
Wolverhampton ..	,, 24	390	+ 14	—	—	—	9½	—
Cen. London Rly. ..	,, 23	7,100	+324	4	27,802	+ 130	6	—
City & S. Lon. Rly.	,, 24	3,227	—140	4	12,791	— 886	6½	—
Dublin—Lucan Rly.	,, 24	92	+ 8	4	313	+ 19	6½	—
L'pool Overh'd Rly.	,, 24	1,497	+ 43	4	6,227	+ 334	6½	—
Mersey Railway ..	,, 23	1,497	+403	3	4,342	+ 1,092	4½	—

INSTITUTION OF ELECTRICAL ENGINEERS.

ELECTRIC TRACTION WITH ALTERNATING CURRENTS.

By A. C. EBORALL, Member.

(*Paper read at Manchester, December 15th*, 1903.)

(*Concluded from page* 158.)

3. *Low Power Factor at Heavy Currents: Armature Reaction.*—The field and armature windings in series offer an impedance to the alternating current traversing them, and the greater the value of this current, the more it lags behind the supply pressure; in other words, the worse the power factor. The latter, in fact, falls from a high value at light loads to zero at standstill. As far as the field system is concerned, the only remedy is to reduce the frequency as much as possible; but with regard to the armature, seeing that it is the armature flux that causes not only the inductive E.M.F. in the armature, but a reaction on the field system as well, it is advisable to reduce it to a minimum. This can be done either with the help of damping coils (Stanley), or by saturating the pole-shoes (Lamme), or by dividing the poles in the axial direction by means of slits (Finzi). The first-mentioned arrangement tends to wipe out the armature flux altogether, and thus to get rid of field distortion and armature reactance; the second and third arrangements tend to reduce the armature flux in amount. As far as the inductive E.M.F. of the armature winding is concerned, this decreases with the frequency.

It will be seen from the above that the real remedy for nearly all the troubles consists in lowering the frequency as much as possible, which, as already stated, is what is being done by the present constructors of these motors. The only disadvantage of this, as far as railway work is concerned, lies in the more costly nature of the generators and transformers; from the point of view of the inductive drop in the rail return, it is, of course, directly beneficial.

For the rest, the alternating current series motor has speed, torque, and other characteristic curves generally similar to those of the direct-current series motor, except that the maximum values of the current and torque occur at a point which is relatively much nearer to the normal values.

Railway motors of this type necessitate step-down transformers being carried on the car, as they can only be worked at low pressures; the speed control is effected by varying the transformation ratio and is hence very economical, this feature of the motor tending to compensate for its relatively lower efficiency.

The motors of the third-class are mixed-action motors; they start as repulsion motors, and after a certain speed has been attained, all the segments of the commutators are short circuited, and they continue to run as induction motors. The type originated with Prof. E. Arnold, under whose patents the Wagner Co., of America, has built many motors for ordinary industrial purposes, but as the Schüler motor is the best representative of the class, it will suffice to refer to it in particular here.

The characteristic features of the pure repulsion motor are its good starting performance and poor running performance. The efficiency and power factor are both low, and for a given output the motor is relatively very heavy. On account of this, and especially in view of the fact that the change can be readily effected, it was but natural to change it into a pure induction motor at or near normal speed, because near synchronism the single-phase induction motor operates at its best. Arnold does this by short-circuiting the commutator segments by a centrifugal device (and raising the brushes simultaneously), while Deri does it by altering the number of stator poles in a similar manner. In both cases the conversion is suddenly performed, and accompanied by undesirable current fluctuations; there is, moreover, a want of flexibility about it which puts such motors out of question as far as traction work is concerned.

In the Schüler motor, however, the transition from repulsion to induction motor is almost imperceptible, as it is effected with the help of slip-rings and a star-connected rotor resistance, through which the rotor windings are gradually short-circuited. The commutator brushes remain short-circuited, and more or less current passes through them, in accordance with the manipulation of the resistance; at normal speed, practically no current passes through them, as the rotor windings are, at this speed, completely short-circuited at the slip-rings. At speeds intermediate between standstill and synchronous speed, part of the rotor current passes through the short-circuited commutator brushes, and part through the rotor resistances; under these conditions the rotor is working partly as a repulsion motor, partly as an induction motor.

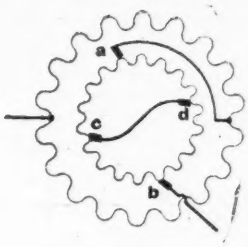
To sum up, the Schüler motor presents the possibility of starting with a large torque without an excessive current consumption, and of speed regulation over a long range with smaller losses in the rotor resistances, than would be the case with the corresponding three-phase motor operating under similar conditions. Its efficiency, power factor, and overload capacity are, however, much inferior to the latter, while, with regard to commutation, it is comparable with the series motor, and what has been said in connection with the commutation of the latter is equally applicable to it. It is thought that while the Schüler motor is exceedingly well worked out, and the best of its class, it will not find a place in single-phase traction work, or, at any rate, that it will not take precedence of the pure series motor, or of the series repulsion motors referred to below; its sphere of utility is more likely to be in connection with elevator and similar work. At the same time, it must be pointed out that the addition of an efficient compensating arrangement to it, so that it would work at a power factor approaching unity over its whole range, would alter the situation; in any case, it has one advantage over the series motor, namely, that no step-down transformer is required. Its stator construction is that of a standard three-phase motor with one phase of the winding always out of use, and the limiting value of pressure would be the same. Its rotor, which in construction resembles the armature of a rotary converter, must always work at low pressure.

This ability to work directly at high pressure is a property also shared by the fourth class of single-phase motors—the Latour and Winter-Eichberg motors. These motors are partly repulsion motors, partly series motors, and are the most interesting, and perhaps also the most promising single-phase motors that have yet been devised. They differ in two important respects from all other series or repulsion motors—the power-factor is nearly unity under all conditions of working, while the field flux is produced by the rotor instead of by the stator, the ampere-turns of the latter being less than those of the former.

In fig. 8 (*a* and *b*) the Latour and Winter-Eichberg mixed action motors are respectively indicated in diagrammatic form, and, as will be noticed, there is no essential difference between them; indeed, these designers seem to have reached practically the same point by different and independent paths. By supplying the commutators at constant pressure (if necessary, through a step-down transformer of suitable size) instead of variable pressure, as indicated in the figure, motors can be obtained the performance of which is analogous to that of direct current shunt motors, and such motors would be applicable to ordinary industrial work, as Latour has pointed out.

The windings indicated in fig 8 (two-pole motors being represented for the sake of clearness) correspond to series wound direct current motors, and hence will be alone referred to in connection with the subject of electric traction. As far as constructional features are concerned, the stators of these motors are just like the stators of ordinary induction motors. Latour, however, prefers to distribute the winding all round the periphery to form a closed circuit, there being thus, in the two-pole motor, two parallel paths traversed by the single-phase current. The rotors are simply specially proportioned direct current armatures with amply dimensioned commutators of many segments; these commutators have to be arranged to work at 200 volts between brushes, or less, which can be readily arranged for if the current transformer of Winter and Eichberg is provided.

Consider, for instance, the motor of fig. 8A, with the brushes *a*, *b* removed, and the single-phase current traversing the stator only. A pure repulsion motor of favourable design would result,



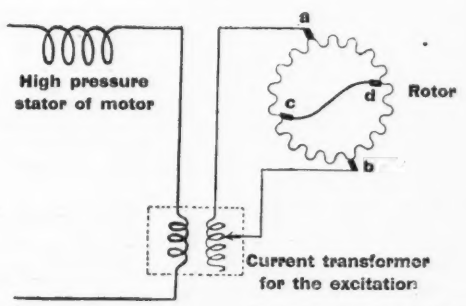


FIG. 8 (A) AND (B).—DIAGRAMMATIC REPRESENTATIONS OF LATOUR AND WINTER-EICHBERG SINGLE-PHASE REPULSION-SERIES RAILWAY MOTORS.

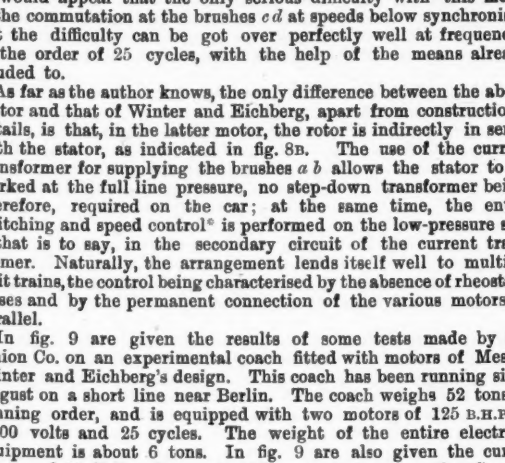
the characteristics of which would be, as Latour has shown, an excellent torque at starting, which decreases with the speed, together with perfect commutation at synchronous speed. As already indicated, however, the power factor of such a repulsion motor is very low, while, unless special arrangements are adopted, the motor sparks badly below synchronism. The defects disappear almost completely, however, directly the armature, with its short-circuited brushes *c*, *d* has current from the external circuit led into it, directly or indirectly, by means of the brushes *a b* placed at right angles to the brushes *c d*, which arrangement results in a repulsion-series motor. The motor now has a power factor of nearly unity at all loads, a starting torque equal to that of a three-phase motor, but not requiring resistances in order to obtain it, a possible speed variation over wide limits by varying the pressure at the brushes *a b*, and excellent commutation under all conditions at these brushes. Working under fixed conditions of supply, the speed and torque characteristics are generally

similar to the corresponding characteristics of the direct current series motor.

Briefly, the current c_1 passing through the rotor from outside by way of the brushes *a b* produces a rotor flux which, in conjunction with the rotation of the rotor in it, causes a current c_2 in quadrature with c_1, to flow through the rotor by way of the short-circuited brushes *c d*. The flux due to one component of of the current c_2 cancels the stator flux, and thus renders the stator windings practically inductionless, and, moreover, by doing away with the stator flux allows of perfect commutation at the brushes *a b*, as the heavy currents in the short-circuited coils which would otherwise be caused by induction from the stator, are now no longer present. Again, the magnetic flux along *c d* forms, with the flux along *a b*, a resultant flux which rotates nearly synchronously with the rotor, and the latter therefore also becomes nearly inductionless, just as is the case with the rotor windings of an induction motor operating near synchronism. It would appear that the only serious difficulty with this motor is the commutation at the brushes *c d* at speeds below synchronism, but the difficulty can be got over perfectly well at frequencies of the order of 25 cycles, with the help of the means already alluded to.

As far as the author knows, the only difference between the above motor and that of Winter and Eichberg, apart from constructional details, is that, in the latter motor, the rotor is indirectly in series with the stator, as indicated in fig. 8B. The use of the current transformer for supplying the brushes *a b* allows the stator to be worked at the full line pressure, no step-down transformer being, therefore, required on the car; at the same time, the entire switching and speed control* is performed on the low-pressure side —that is to say, in the secondary circuit of the current transformer. Naturally, the arrangement lends itself well to multiple unit trains, the control being characterised by the absence of rheostatic losses and by the permanent connection of the various motors in parallel.

In fig. 9 are given the results of some tests made by the Union Co. on an experimental coach fitted with motors of Messrs. Winter and Eichberg's design. This coach has been running since August on a short line near Berlin. The coach weighs 52 tons in running order, and is equipped with two motors of 125 B.H.P. at 6,000 volts and 25 cycles. The weight of the entire electrical equipment is about 6 tons. In fig. 9 are also given the curves (shown dotted) for the new 125-B.H.P. motors on the Central London Railway † in order that a ready comparison may be made


Current of direct current railway motor at 500 volts
Current of single-phase railway motor at 6,000 volts, 25 cycles
Velocity in miles per hour
Drawbar pull of motor in pounds
Percentage efficiency and power factor
Efficiency of A.C. motor (r = 24 : 1)
Velocity curve for A.C. motor (r = 24 : 1)
Drawbar pull of A.C. motor (r = 24 : 1)
Efficiency of A.C. motor (r = 8·3 : 1)
Velocity curve for A.C. motor (r = 8·3 : 1)
Drawbar pull of A.C. motor (r = 8·3 : 1)
Efficiency of D.C. motor
Velocity curve for D.C. motor
Drawbar pull of D.C. motor

[NOTE.—The dotted efficiency curve applies to the D.C. motor.—EDS.]

FIG. 9. — CURVES OF 125-B.H.P. WINTER-EICHBERG RAILWAY MOTOR, AND OF 125-B.H.P. G.E. DIRECT-CURRENT RAILWAY MOTOR.

between a standard direct current equipment of latest design and the single-phase equipment. For the latter, it will be noticed that two sets of curves are given. These correspond to the maximum and minimum ratios employed, and hence indicate the conditions prevailing at light and heavy loads respectively. Between these limiting transformation ratios of 24 : 1 and 8·3 : 1 there are a number of others, the motor having similar characteristic curves for each. It will be seen that the efficiency of the single-phase motor is not much below that of the direct current motor, while the speed control is equally flexible. The power factor, moreover, is good over the whole range, while with regard to the commutation under different conditions, the author has no information.

Whether one or other of these types of single-phase railway motor will eventually succeed in taking the place of the three-phase motors remains to be seen, but from what has been said above it will be recognised that a lot of good work has been done in this direction during the last year or so. The commercial application of such motors will largely depend upon the quality of the commutation under traction conditions, and with regard to this it must be borne in mind that the difficulties are, and always will be, very much greater than with direct current motors. But one thing is quite certain—what with the new type of compounded alternators, the compensated three-phase motors and the various new single-phase motors, electrical engineers will have to reckon with the commutator in alternating current machinery, and some modification of certain ideas at present held may confidently be expected in the near future.

Unfortunately there was not much discussion, as the copies of the paper were ready so late that it was impossible for members to have them before the meeting.

A very hearty vote of thanks was accorded to Mr. Eborall.

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* The author has been unable to ascertain whether *the whole* of the speed regulation is effected by means of varying the transformation ratio of the transformer. It may quite well happen that supplementary arrangements are provided in the exciting circuits in order to get a means of fine regulation.

† "The Central London Railway," by H. F. Parshall, E. Parry and W. Casson.—*Traction and Transmission*, Vol. vii.

ROYAL COMMISSION ON LONDON TRAFFIC.

THE Commission resumed its sitting on Thursday of last week at Westminster Palace Hotel, Sir David Barbour in the chair.

Mr. Alderman CROSLEY said that the principal obstruction to traffic existed in the City, and to get rid of it, he would banish omnibuses from coming into the centre of the City. The travelling public could be brought to the confines of the City by tube railways —three of which he thought should be constructed—one from the north and two from the south, and connected with one another by a circular omnibus route. He would leave the construction of these underground railways to private enterprise.

Mr. Deputy PRYKE, chairman of the Bridge House Estates Committee, gave particulars as to the cost of the various City bridges. He said the Corporation had spent £3,500,000 on construction, and in addition a large annual sum for maintenance. As the tramway authority within the City, the Corporation had always resolutely set its face against the introduction of tramways into the City. During the last 50 years they had spent upwards of £6,000,000 in effecting street improvements in the City, and the introduction of tramways would, in his opinion, largely nullify the benefit which had resulted from that large expenditure. He would regard it as a very serious matter if tramways were allowed to cross any of the bridges under the control of the Corporation.

Mr. ANDREW MURRAY, the city surveyor, said he thought that greater powers should be given to the local authorities to prevent the breaking up of streets in the City by electric lighting and other companies. He also thought that omnibuses, cabs, and all public vehicles should be absolutely under the control of the police, and be licensed by them. He agreed with the previous witness in his objections to allowing tramcars in the City or over any of the City bridges. The Commission adjourned.

At the sitting of the Royal Commission on Friday, evidence was given by Capt. NOTT BOWER, the Commissioner of the City Police, who referred to the steady increase in the City traffic. His evidence was mainly devoted to the constant breaking up of streets.

Supt. FRANCIS, of the City Police, also gave evidence.

RADIUM AND RADIOACTIVITY.

Abstract of a Lecture delivered before the Aberdeen Society of Mechanical Engineers, by J. GRAY, B.Sc., A.R.S.M.

THE nineteenth century has been characterised in many different ways, but no more appropriate name could be applied to it, by physicists and chemists at least, than the century of the Atomic Theory.

For about three years after the beginning of the nineteenth century, the Atomic Theory sprang almost fully equipped from the brain of Dalton, and two years before its close Prof. J. J. Thomson showed by his discovery of the corpuscle, a particle whose mass was only $\frac{1}{1000}$ part of the mass of the smallest atom, that the indivisibility of atoms was no longer universally true.

The atomic theory assumed that all elementary substances were made up of small particles, called atoms, all similar, and incapable by any known means of being further sub-divided. Hydrogen gas, for example, consisted of an aggregation of atoms of hydrogen, the lightest of all known atoms; oxygen gas of an aggregation of atoms of oxygen, each atom of oxygen having 16 times the mass of an atom of hydrogen, and so on, each substance having its own peculiar atom, differing from the atoms of other substances in mass and in other respects.

It was found that most of the atoms had the power of cohering, or sticking to each other, or to other atoms, by a force which was called *chemical affinity*. For example, hydrogen was found not to consist of isolated atoms, but of pairs tied together by a single bond; oxygen consisted of pairs tied together by two bonds. Hydrochloric acid, which is a compound substance, was found to consist of an atom of hydrogen tied to an atom of chlorine by one bond.

Six is the maximum number of bonds known to belong to any single atom, and some atoms, like those of helium, have, as far as is known, no bonds at all, since they have never been known to combine with any other atom. Bonds may become latent in pairs, and the number of active bonds that remain is called the *valency* of the atom.

The faith of chemists and physicists in the absolute indivisibility of the atom was unshaken till 1899, when Prof. J. J. Thomson discovered that the cathode rays consisted of a stream of particles whose mass was only $\frac{1}{1000}$ part of the mass of an atom of hydrogen, *i.e.*, of the smallest of all the atoms.

When a discharge of electricity is sent through a vacuum tube, very highly rarefied, a faintly luminous beam may be seen proceeding from the negative electrode. This beam has been shown to consist of a stream of exceedingly minute particles, each charged with the same amount of *negative* electricity. The beam can be deflected by a magnet, and this shows that it is electrified; and the direction of the deflection shows that the charge on each particle is negative.

By a combination of refined experiment and mathematical calculation, both the mass and the electric charge of these particles have been measured. The particles have been named corpuscles by their discoverer, J. J. Thomson; others have called them electrons or negative electrons, because they contain the atom or smallest known quantity of electricity. An atom of hydrogen has an equivalent positive charge, and is, therefore, sometimes called a positive electron. Both positive and negative electrons are also called ions, which means movable particles with a free charge of electricity. Ions are the unsatisfied members of a dissociated pair.

The phenomena of electrolysis point to the remarkable conclusion that the corpuscles or negative electrons are in reality the chemical bonds, which bind the atoms together to form molecules, such as have been referred to above. Helmholtz expressed the meaning of Faraday's laws of electrolysis as follows: "Every single valency of an elementary or compound ion is charged with exactly the same quantity of positive or negative electricity, which behaves as if it were an electric atom, and cannot be further sub-divided." Now the charge of a single valency has been shown to be exactly the same as that of a corpuscle in the cathode rays. The conclusion is therefore suggested that the corpuscle is a single valency or active chemical bond.

Chemical affinity is thus merely electric attraction. All atoms, pure and simple, have a positive charge, and they are tied together by their attraction for the negative electron or corpuscle to form molecules.

The discovery that the corpuscles could be detached from the atoms was the first blow to the atomic theory. But as this merely means that the $\frac{1}{1000}$th part of the mass of the smallest atom can be detached, it was still possible to maintain that the integrity of the atom had not been seriously interfered with. This last position must now, however, be abandoned, for the discovery within the last few years of radioactivity has led to the conclusion that the heaviest or most massive atoms, at least, are liable to be completely broken up into smaller fragments.

The three most important radioactive substances yet discovered are radium, uranium and thorium. They have the highest atomic weights of all known substances. The atomic weight of radium, according to Sir W. Ramsay, is 250; of uranium, 238; and of thorium, 232. These numbers indicate how many atoms of hydrogen are required to make up one atom of each radioactive substance.

When a camel is overloaded, the last straw "breaks its back." We shall see that these overloaded atoms are also liable to break down when the last straw is applied.

Imagine the illustration (fig. 1) to be an atom of radium. This atom is equal in mass to 250 atoms of hydrogen. The radium atom, like all atoms, behaves like an indivisible entity in all ordinary chemical reactions; it combines, for example, with bromine to form radium bromide; it has two bonds, and therefore combines with two bromine atoms which have each only one bond.

These are ordinary chemical reactions. But it has been found recently that under certain circumstances the radium atom breaks up into smaller atoms; it is transmuted, in fact, into helium, a substance with an atomic weight of only 4. If the radium were completely disintegrated into helium, it would have to break up into about 60 pieces. The larger pieces thrown off in the disintegration of the radium atom have positive charges of electricity. Let us suppose that A, B, C and D in fig. 1 represent four of these positively charged sections. These sections must be bound together with a very strong cement, and what cement could be stronger than a layer of corpuscles or negative electrons? If at rest these atoms would not disintegrate, but let us suppose that each atom is rotating about its axis at an enormous speed. When a large grindstone or a large fly-wheel rotates too fast, it flies to pieces; and the energy of these pieces is so great that they produce a considerable effect on all bodies in the neighbourhood. The grindstone or fly-wheel may be said to be radioactive. A certain number of radium atoms are broken into pieces by centrifugal force, and thus is their radioactivity explained.

If the centrifugal force of the radium atom were of itself sufficient to break up the atom, then the whole of the radium would disappear in an instant. But only a very small fraction of the total number of atoms break up each moment, so that we must assume that the centrifugal force by itself is not quite sufficient to break up the atom. We have to look for the last straw which brings about the final collapse.

The kinetic theory of gases teaches us that the atoms of a gas are constantly moving and colliding with each other. The average velocity of the atoms is constant at a constant temperature, but some of the atoms have lower velocities, and some higher velocities, than the average. The ordinates of the curve in fig. 2 represent the number of atoms having velocities above and below the average (A). The number of atoms having a velocity, say, 1,000 times the average, is very small; and still smaller would be the number having a velocity 1,000,000 times greater than the average; but still there would always be a few atoms with these extreme velocities. The impact of collision of these atoms would be terrific, and this impact may well be the last straw which breaks up the atom and liberates the energy of its rotation.

Radium gives off three kinds of rays called α, β and γ rays. The α rays are the large positive pieces of the atom; the β rays are the negative electrons or corpuscles; the γ rays are of the same nature as Röntgen rays, *i.e.*, irregular waves in the ether (etheric noise), produced by the crash of the explosion when the atom breaks up.

The break up is not completed at once, it takes place by steps, and several intermediate substances are produced before the final helium stage is reached. These intermediate substances are the emanation, and three kinds of excited activity. The final rays

FIG. 1.

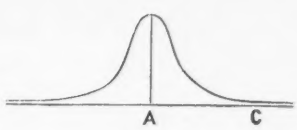


FIG. 2.

emitted before the helium is reached, appear to consist mostly of corpuscles. This is probably the layer of corpuscular cement with which the constituent sections are coated. It is from this final discharge that most of the heat is derived which radium continually emits. This is explained on the principle that the bullet fired from a gun contains most of the energy of the explosion; the gun contains only a very small fraction.

Besides heat, radium can be made to constantly generate electricity. If it is placed in a glass tube, the tube acts as a sieve, which allows corpuscles to pass, but stops most of the positive electrons. Thus a constant supply of positive electricity can be drawn off from the tube.

Sir William Ramsay has shown by means of the spectroscope that the emanation gradually changes into helium. Helium is an element with an atomic weight of 4, and is not known to combine with any other element. It is to be inferred, therefore, that it is a neutral atom. It is probably a combination of positive and negative electrons in the exact proportions necessary to neutralise each other, and may yet be broken up into hydrogen atoms and corpuscles.

One of the most interesting manifestations of the activity of radium is its power of breaking up the molecule of air into ions and thereby making it a conductor. An ion is a free positive or negative electron or any combination of them with an excess of positive or negative electricity. As the ion is free to move, under the influence of electric force, it is able to carry away the charge of an electrified body. This action can be shown by means of a gold leaf electroscope. It is by this property that the activity of radioactive substances is measured.

Radium continuously emits a definite amount of heat; 1 lb. of radium would emit heat at a rate equivalent to $\frac{7}{100}$ H.P. The heat, as has already been pointed out, arises chiefly from the bombardment of surrounding matter by corpuscles or negative electrons given off in the last stages of disintegration of the radium atom.

Radium is made from pitchblende by a long series of chemical processes, by which more and more radioactive material is gradually separated out; 1,815 tons of pitchblende would be required to make 1 lb. of radium.

The molecules of solid bodies are not so easily broken up by the radium projectiles as those of gases; but if the impact of the projectile is not sufficiently great to break up the molecule into its constituent atoms and corpuscles, it may still be sufficient to cause the corpuscles to oscillate about their position of stable equilibrium. Now, when corpuscles oscillate with sufficient rapidity, they emit rays of light, as is proved by an experiment known as the Zeeman effect. This will explain how it is that the rays emitted by radium cause certain bodies to fluoresce. Sulphide of zinc fluoresces when exposed to the action of radium. A still better fluorescence is obtained from the platino-cyanide screen used in Röntgen ray work. The strongest fluorescence of all, however, is obtained with a mineral called willemite, composed mainly of silicate of zinc. These fluorescent effects are only obtained in a marked degree with the strongest radium bromide or chloride, and they do not form so delicate a test for the rays as the ionisation of air. Certain kinds of diamonds also fluoresce under the action of radium.

The rays of radium have been shown to be fatal to almost all kinds of bacteria. A great many experiments have been made on different kinds of germs of disease, and in almost all cases exposure to the rays of radium for a few minutes has destroyed the germs so that they do not grow and multiply in a gelatine medium. This has been strikingly shown by Mr. Crookes, who allowed the rays to pass through a hole in a metal disc, and strike on a small part of a mass of gelatine containing germs. When the germs were developed the whole of the gelatine darkened except on the spot where the rays had struck.

Several cases of the cure of external cancer by radium have recently been recorded.

For the cure of consumption, Mr. Soddy recommends that the emanation of thorium should be inhaled into the lungs. The rays emitted by the emanation and the excited activity, would then be projected directly on the tubercular germs, and probably result in their destruction. But it must not be forgotten that a long

exposure to the rays will destroy healthy tissue, and the method must therefore be cautiously applied.

It was the dream of the alchemists to transmute the baser metals into the nobler. The transmutations that accompany radioactivity are, unfortunately, in the opposite direction. But the question naturally arises—how were the ponderous overloaded atoms of these radioactive substances produced? The hypothesis of the constitution of the radium atom which I have ventured to put forward suggests that the radium atom was produced by the compression of a group of the molecules of smaller atoms by the application of enormous pressure. Such conditions are present at the centre of the earth, where radium, if this theory is correct, must be much more abundant than at the surface. Sand is compressed into sandstone with much less pressure. The temperature of the earth increases as we go down towards its centre; this may be due to radioactive substances. It has been calculated that the heat of the sun would be accounted for by the presence of less than $\frac{1}{10}$ oz of radium per cubic yard.

In conclusion, whether my hypothesis is correct in every detail or not, there is no doubt that we are at the beginning of a new era in our knowledge of the constitution of matter—an era which may see the cure of many diseases that now defy the skill of the physician, and place a new source of energy at the disposal of mankind.

APPLICATION OF SINGLE-PHASE ALTERNATING CURRENT FOR TRACTION AND RAILWAY SERVICE.*

By B. G. LAMME.

THE present direct-current railway system has limitations in voltage, speed control, &c., which have long been recognised by the electrical profession. Many systems have been devised with more or less success—generally with less—in order to overcome these limitations, so that the possible field for the direct-current systems could be extended. It has also been recognised by some of those familiar with the problem that a single-phase alternating-current motor having the characteristics of a direct-current series motor would at once furnish a means of attaining many results now impossible with the direct-current system. Such a motor obtained, then the voltage limitation can at once be removed, as the transforming properties of alternating current can be brought into use. Also economical operation at any desired speed can readily be obtained through the same property of alternating current. Furthermore, the use of single-phase permits a single overhead wire where track return is used, thus retaining a most valuable feature of the direct-current system. It is thus evident that a motor of this character will permit the retention of most of the present advantageous features of the direct-current system, and also enables the use of other features not permissible without great complication and expense with the present direct-current system.

There has been perfected only one class of single-phase motors which possess the characteristics of the direct-current railway motor, and this one class of motors very closely resembles the direct-current machine in the general features. These motors may all be given the general name of commutator type single-phase motors, as all of them have commutators on the armature or rotating member, and the armature is provided with a direct-current type of winding. Some variations from the usual types of armature windings have been proposed, but the various direct-current types have proven most successful.

All these commutator types of motors which have the variable speed characteristics suitable for railway service, may be broadly classified as belonging to the series type. By this we mean that the field or exciting current is in series with the armature circuit, either directly or through transformer action, either in the motor itself or outside the motor. The series type of motor can be subdivided into two classes, viz., the straight series motor, in which the current in the field wholly or partly passes through the armature, or *vice versâ*; and those in which the field or armature forms a secondary circuit, the primary of which can either be part of the field structure of the motor, or may be outside of the motor. All these motors—whether of the straight series or of the transformer type—have the property that the field magnetism varies with the load, although not necessarily in direct proportion. Hereafter we will refer to these two types as the straight series and the transformer types of motors. All these motors are related to a greater or less extent in their characteristics, and in many instances one type can be readily changed to the other type. In fact, by closing a single switch, we have changed a straight series motor into the transformer type with the armature closed on itself, forming a secondary circuit, with a change in performance apparently due only to the amount of material in the magnetic circuit being insufficient for the best performance as a transformer type.

In these commutator type single-phase motors, the two most important elements, besides the speed characteristics, are the efficiency and the power factor. The efficiency of such motors will usually be less than that of a direct-current railway motor of the same output. The losses in one of these alternating-current motors can be considered as made up of the following elements:—

1. Iron loss due to reversals of magnetism in armature and field at the frequency of the supply circuit

2. Armature iron loss due to variations in magnetism dependent upon rotation of the armature.

3. Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element.

4. Losses in field windings.

5. Loss in armature windings.

6. Brush losses.

7. Friction and windage.

Comparing these losses item by item with those of a direct current motor, we see at once that certain losses will necessarily be greater than in the direct current motor.

1. Iron loss due to the frequency of the supply circuit and induction in the primary element. No such loss exists in a direct current motor, as the machine is excited by continuous current. This loss in the alternating current motor will not be relatively large unless the motor is worked at a very high induction, or unless the construction of the magnetic circuit is such as will allow eddy current losses. It is at once evident that the field magnetic circuit must be laminated as completely as the armature circuit, and that there are no local circuits permissible in the field structure. It is also evident that the field structure of a straight series motor will, in general, have lower losses than that of the transformer type, where the field itself forms part of the transformer, as in this latter case the total induction in the field structure will generally be greater than in the series type.

2. Armature iron loss due to variations in magnetism dependent upon rotation of the armature. There will be a loss in the armature due to the alternating magnetism from the primary or the field circuit. This can be charged against the field loss or primary loss, as mentioned above. In addition to this loss, there is a loss due to the rotation of the armature in the field. This will be dependent upon speed of rotation, inductions in the core, teeth, &c., and, in general, will practically average the same as that of a direct-current motor of the same capacity.

3. Iron loss in the surface of field and armature due to the bunching of magnetic lines from the teeth of either element. This is a loss which appears to some extent in the field pole face of direct current machines, due to the bunching of the lines from armature teeth. This loss is relatively small on direct current machines, if the poles are properly laminated, and if the air-gap is relatively large compared with the width of the armature slots. This loss in direct current motors is included in the armature iron loss measurements, due to the methods generally used for determining iron loss on such motors. This loss will appear in the field surface or face of the alternating motor, and may be considerably greater than in the direct current if a smaller air-gap is used than in direct current practice. By air-gap we mean clearance from iron to iron.

If the field structure is of the slotted type, the slots being of such form as to give bunched lines, then there will also be a loss in the armature surface due to the bunching of these lines. It should be noted that the frequency of the secondary currents set up by the bunched lines from armature or field teeth is generally very high compared with the frequency of the supply circuit, or of that due to the rotation of the armature in the field. We believe that in general the loss due to the bunched lines will not be much greater in the alternating-current single-phase motor than in the direct-current, except where very small air-gaps are used on the alternating-current motor.

4. Loss in field windings.—This loss is very similar to that in direct-current machines, as the amount of copper in the field windings will generally be no greater than in direct-current motors of the same capacity, and may even be considerably less. The straight series motor will generally have a lower copper loss than the transformer types where the field structure is used as the primary of the transformer.

5. Loss in armature windings.—The loss in the armature windings will be very similar to that in a direct-current machine, as far as the working current is concerned. In addition to the working current, there may be secondary currents in the armature turns short-circuited by the brushes, which still further increase the armature loss. The resultant armature loss may therefore be somewhat greater than on a corresponding direct-current machine, unless the normal resistance of the armature winding is reduced below that of a corresponding direct-current machine. In practice the loss in the armature winding is made practically equal to that of the direct-current machine, in order to avoid increased heating.

6. Brush losses.—The brush losses due to the reversal of current in the single-phase alternating-current motor are generally somewhat greater than in a direct-current motor. Such motors are usually wound for a comparatively low voltage on the armature, and thus greater brush capacity is required than in direct-current practice. The brush losses are thus increased, due to the greater number of brushes, and in addition there may be local currents in the short-circuited coils, which may produce additional loss in the part of the brush next to the commutator. In practice this loss is evidently comparatively small, as our experience shows no signs of deterioration in the brushes in regular service. Therefore, the increased brush loss may be considered as principally due to the increased number of brushes required.

The brush loss due to the local currents in the short-circuited turns can be reduced considerably by the use of very narrow brushes—a brush spanning one bar or even less. With such a brush there would be short-circuiting only while the brush was bridging two bars, while at intermediate positions there would be no local current. As, in general, the commutators of such motors have a relatively large number of bars, this would mean a very thin brush, possibly less than $\frac{1}{4}$ in. in thickness. Such brushes we consider too thin for street-car purposes, as any roughness on the commutator would tend to break the brushes. In some of our very early experiences with such motors, we used brushes of $\frac{1}{4}$ in. in thickness, but found they

* New York *Electrical World and Engineer*.

required entirely too much attention, and therefore they were abandoned in favour of brushes of a thickness corresponding to direct current practice, the later designs of motors permitting the use of such brushes.

7. Friction and windage.—The friction in bearings and the windage loss in such motors will be very similar to the corresponding losses in direct current motors, but the brush friction loss will, in general, be somewhat greater, due to the increased brush capacity. Also the large number of commutator bars generally used tends to increase brush friction to some extent.

It is evident from the above considerations that the various losses in different parts of the single-phase alternating current motors are either equal to or greater than the losses in the corresponding direct current motor, although no individual loss, except that due to the reversal of magnetism in the field, may be much greater than in the direct current motor. The sum total of the slight increases makes a difference of from 1 to 5 per cent. in the efficiency of the motor, this difference being less with larger motors.

The frequency of the supply circuit also has a small effect on the efficiency, although the relation of the losses in the various parts is so involved that no definite figure can be given for this effect.

The losses in the single-phase motor are, to a certain extent, dependent upon the speed at which the motor is operated, with a given current and torque. Assuming a given current with the motor running at reduced speed, we can note the effect on the losses as follows :—

The iron loss due to the frequency of the supply circuit is changed but little. The iron losses due to changes in magnetism in the armature, and due to bunching of lines from the teeth, are very considerably decreased due to the lower armature speed. The losses in the field and armature windings are practically unchanged, and short-circuit loss in the brushes is not greatly changed. Friction losses in brushes, bearings and windage are all decreased. Therefore, at lower speed, the actual losses in the motor are considerably decreased, but not in proportion to the decrease in output of the motor. Therefore the efficiency decreases slightly with the reduction in speed with a given torque, this efficiency decreasing more rapidly the more nearly the zero speed is approached.

With changes in load, with a given voltage applied, the efficiency curve has very much the same shape as the efficiency curve of a direct-current motor, starting low at light load and high speed, and rising to a maximum, and then falling off considerably at very heavy overloads.

After efficiency, the next most important consideration in the performance of such motors is the power factor. This is a feature which does not appear at all in direct-current machines, as the apparent input in such motors represents true energy. In the single-phase railway motor the apparent input in general does not all represent true energy, as a certain component of the input is required to magnetise the motor, and this component represents practically no energy. Also magnetic leakage in the alternating motor represents a component of the apparent input which is practically wattless.

In a straight series motor a certain magnetising current is required with a given field winding. The alternating flux through the field winding sets up alternating E.M.F.'s, which lag practically 90° behind the energy component of the motor, and the product of the field current by the field voltage thus represents a wattless component of the input of the motor. With increase of load, the field current increases, the induction increases, and therefore the field volts also increase. The wattless component in the field thus varies with the product of two values which are both increasing with the load. The energy supplied to the motor increases approximately in proportion to the current supplied. Therefore, the wattless component in the field increases more rapidly than the energy component. Consequently, if this were the only wattless component in the motor, the power factor would decrease with the increase of load and would be highest at no load. Other wattless components of the input are represented by the cross magnetising effect of the armature, if such exists, and by the stray field around the windings. As these effects will also increase more rapidly than the energy component, it is therefore evident that the power factor in this type of motor will be highest at no load or at highest speed, and will decrease with the load or speed with a given voltage applied. But if the windings are so proportioned that the wattless component at the rated capacity is relatively small, then a high power factor will be obtained at the rated load and speed. At lighter loads and higher speeds the power factor will be considerably higher. Such a motor can give very high power factors at half loads with correspondingly increased speed. If the motor is operated at lower voltages, then the power factor at a given speed will be very nearly the same as when operated at the same speed at a higher voltage and higher load. Therefore, it is evident that as the speed is reduced, no matter what load is carried, the power factor will be decreased, and at start the power factor will be lowest, as the energy component in this case represents only the losses in the motor. We have tested a 100-H.P. motor showing 92 per cent. power factor at 100 H.P., and approximately 98 per cent. power factor at one-half load, the voltage being the same in both cases. This question of power factor is largely a question of design, as the magnetising or exciting component of the input depends upon the air-gap, amount of material, &c. In general, larger air-gap means more exciting current.

The magnetic leakage in these motors may be relatively high, or may be comparatively low, this being to a considerable extent a function of the design of the motor, just as in all alternating-current machinery. Generally it is made as low as possible without sacrificing other important features.

If the armature cross induction in a series motor is large, due to excessive armature ampere-turns per pole, small air gap, &c., the armature self-induction will be large. Increasing the number of poles will reduce the cross-magnetising effects, but at the same time will require somewhat smaller air-gap or increased excitation. These two features are, therefore, to a certain extent, balanced against each other.

There are various schemes for improving the power-factor of the commutator type single-phase motors. These are generally most effective at high speeds, but at start or at very low speeds the improvement is small. In certain designs both of straight series and of the transformer type motors, the magnetising current can be supplied in whole or in part to the armature circuit instead of the field magnetic circuit by means of brushes on the commutator. At certain speeds, this current can be supplied at a considerably reduced voltage, thus requiring a reduced magnetising input compared with excitation applied to the field. This excitation can be supplied from the secondary of a series transformer, the primary being in circuit with the primary winding of the armature. The armature excitation will thus vary as the field excitation would normally vary, thus giving the varying field induction, and the series speed characteristics. While this arrangement is effective in improving power-factor at certain speeds, yet, as a rule, this gives the least effect at the time when it is most required, viz., at start and at very low speed. This method also requires a second system of brushes on the commutator, thus spacing the brushes on the motor the same distance apart as if double the number of poles were used. For instance, a four-pole motor would have brushes spaced 45° apart instead of 90°. At start there should be practically the same input required for magnetising, whether the current is supplied to the armature or to the field.

Comparing the straight series with the transformer type of motor, it should be noted that the straight series motor requires less magnetising current, as the magnetising current is only supplied to one element of the field. With the transformer type of motor a magnetising field must be furnished as in the straight series, but there is also a second field set up due to the transformer action, and this also requires a magnetising current. In other words, it may be considered that there are two magnetic fields set up, approximately 90° apart, each field requiring a certain magnetising current. These two fields may be considered as forming one resultant field of higher value than either of the components, with a magnetising current of higher value than either component. In the series motor the transformer part of the field can be made to practically disappear, only the exciting field remaining; the resultant induction is, therefore, much less than with the transformer type, the field having an approximate average value of 70 per cent. of that of the transformer motor, the magnetic circuit being reduced in proportion.

It thus appears that the straight series motor can be made to give a somewhat higher power factor than the transformer type, with the field used as a transformer, and this is obtained with somewhat less weight. This difference in power factor could be compensated for at higher speeds by some means of excitation applied to the armature through the commutator, as indicated above. But for traction service, where the least weight with great compactness of design is desirable, it appears to us that the straight series motor possesses some advantages. The transformer type of motor with the transformer in the motor itself can be compared with the straight series motor with a separate transformer, if high voltages are to be used on the line. We consider that a number of more compact motors under a car with one separate reducing transformer forms a more suitable combination than a similar number of larger motors, each with its transformer inside itself.

There is one other method of improving the power factor on these motors, and that is by the use of resistance in series with the motors. If the voltage on the motors is controlled by the use of an external rheostat, as is common with direct-current motors, then the power factor with a given torque will be constant and independent of the speed. With a given torque the wattless component of the input of the motor is practically constant independent of the speed, and if the speed is controlled by rheostatic loss, then the energy component will also be practically constant, and the power factor can be made higher at all loads. This may appear to be a good feature to those who have not considered the problem carefully, but it is a fact that a high power factor obtained in this way represents a less desirable condition than the low power factor which would be obtained if the rheostatic method of starting were not used. With a given wattless input from the circuit, the best possible condition as regards effect on the supply system is that represented by the minimum expenditure of energy. A wattless component has a certain effect on the regulation of the system, and any improvement in power factor by increasing the energy component means that much additional effect on the supply system.

(To be concluded.)

WATER DISTILLERS AND CONDENSERS.

THE difficulty in many parts of the world, notably in Egypt, and in some parts of South Africa, of obtaining pure water for boiler feed gives the subject of water distillers a peculiar interest to all engineers.

During a recent visit to the works of the Mirrlees Watson Co., Ltd., of Glasgow, we saw two very large water distilling plants recently made for the Egyptian Government. These, we believe, are by far the largest plant ever manufactured for this purpose; each is capable of producing 350 tons of water per day when working at its maximum effi-

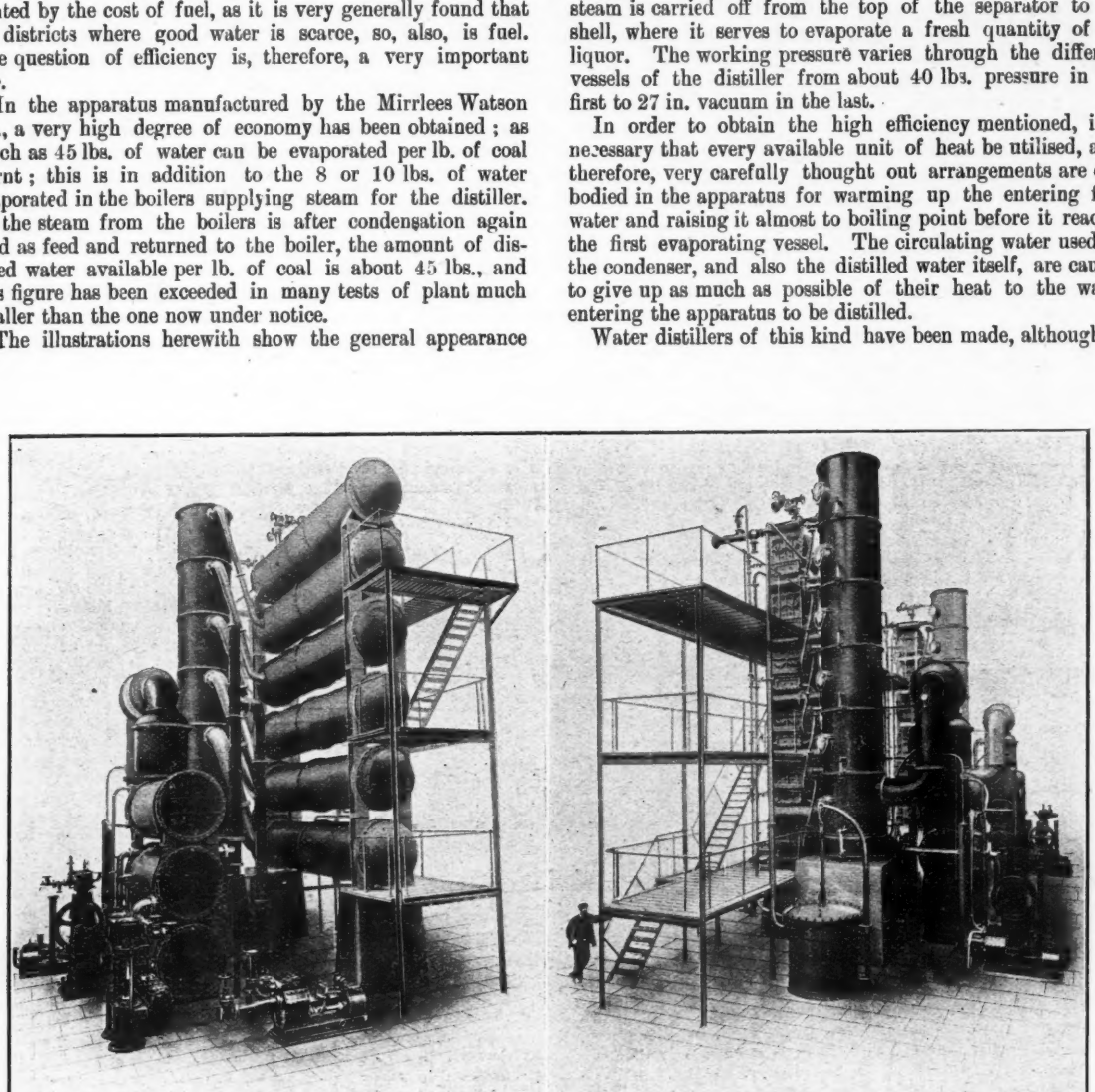
ciency, and can produce considerably larger quantities at a slightly greater expenditure of coal per ton of water evaporated.

This plant is to be erected at Suakim, where it will be used to supply water for locomotive and other boilers as well as for drinking purposes.

The use of distillers has, in many instances, been prevented by the cost of fuel, as it is very generally found that in districts where good water is scarce, so, also, is fuel. The question of efficiency is, therefore, a very important one.

In the apparatus manufactured by the Mirrlees Watson Co., a very high degree of economy has been obtained; as much as 45 lbs. of water can be evaporated per lb. of coal burnt; this is in addition to the 8 or 10 lbs. of water evaporated in the boilers supplying steam for the distiller. As the steam from the boilers is after condensation again used as feed and returned to the boiler, the amount of distilled water available per lb. of coal is about 45 lbs., and this figure has been exceeded in many tests of plant much smaller than the one now under notice.

The illustrations herewith show the general appearance



Sextuple-Effect Distillers, Surface Condensers, &c., for Suakim (Mirrlees Watson Co).

of the two plants as erected in the shops of the Mirrlees Watson Co. As the total height of the distillers exceeds 39 ft., it will be seen that considerable manufacturing facilities are necessary for the production of such apparatus, and that the erection of the plant on the working site is an operation requiring a considerable amount of engineering skill.

The distillers are designed on the well-known Yaryan system of multiple evaporation; each plant consists of a sextuple effect distiller with surface condensers, and is provided with preliminary heaters and the necessary air and water pumps; there are also, combined with them, a salt-water filter and a set of filters for aerating that portion of the distilled water which is to be used for drinking purposes.

In the present instance, each plant consists of six cylindrical vessels containing tubes; the liquor to be evaporated is passed through the tubes, the steam from the boiler being admitted to the shell of the first vessel. The pressure is graduated, being less in each effect than in the preceding one; the boiling temperature of the liquid is, therefore, lowered as it passes from effect to effect, and it is thus possible to boil the water in one effect by absorbing heat from the steam which was given off in the previous effect. To do this the water, after passing through the tubes of each vessel, is passed into a separator (the vertical vessel seen in the illustrations consists of six separators, one on the top of the other). In these separators the liquid falls to the bottom, and is passed into the tubes of the next effect; the steam is carried off from the top of the separator to the shell, where it serves to evaporate a fresh quantity of the liquor. The working pressure varies through the different vessels of the distiller from about 40 lbs. pressure in the first to 27 in. vacuum in the last.

In order to obtain the high efficiency mentioned, it is necessary that every available unit of heat be utilised, and, therefore, very carefully thought out arrangements are embodied in the apparatus for warming up the entering feed water and raising it almost to boiling point before it reaches the first evaporating vessel. The circulating water used in the condenser, and also the distilled water itself, are caused to give up as much as possible of their heat to the water entering the apparatus to be distilled.

Water distillers of this kind have been made, although of smaller capacity, for Mombassa, Western Australia, Perim, the Argentine Republic, Russia, and many other places, and the firm have now in hand three plants for the Cape of Good Hope Railways.

Another speciality of Messrs. Mirrlees Watson Co., seen in their shops at the same time, consisted of a number of large condensing plants to fill orders both from abroad and from corporations and public companies at home. In all these condensers the counter current system is used, the entering steam meeting the stream of condensing water which is just leaving the condenser. The standard pumps are of the Edwards type, but, in addition, pumps are also made working on either the single or two-stage system.

The frames of the pumps manufactured by the firm are not of the ordinary type, but consist of a single casting, this gives a much neater appearance than the usual construction, and the pumps are made in units arranged so that they can be combined into sets of two or three, or used singly, according as to whether the capacity of the condenser requires single, double, or three-throw pumps to be used. There was also under construction a self-draining jet condenser.

Condensing plant is an important part of the plant produced by the Mirrlees Watson Co., the condensers turned out by them during last year being capable of dealing with nearly half a million lbs. of steam per hour, equivalent to over 100,000 H.P.

THE BREAKAGE OF TROLLEY WIRES.

[BY OUR LEGAL CORRESPONDENT.]

THE accident at Brentford, in which two horses were injured owing to the breakage of trolley wires, once more draws attention to the liabilities of electric tramway companies who make use of the overhead system. The consequences of an accident of this kind may be so appalling, that it is of the last importance that the wires themselves, and the supports which hold them above the rails, should be made the subject of constant inspection.

It may be convenient to present to the readers of the REVIEW a short statement of the legal liabilities imposed upon electric tramway companies who erect and maintain wires of this kind.

In the first place, it may be stated that by the Tramways Act, 1870, Sec. 55, which applies to every tramway company, it is provided that the promoters or lessees (or a tramway) as the case may be, shall be answerable for all accidents, damages and injuries happening through their act or default, or through the act or default of any person in their employment by reason or in consequence of any of their works or carriages, and shall save harmless all road and other authorities, companies or bodies, collectively and individually, and their officers and servants, from all damages and costs in respect of such accidents, damages and injuries.

That the above provision prevents a tramway company raising the defence that they are protected from actions for negligence owing to the fact that they work under statutory powers has been made clear in a number of cases. In Sadler *v.* South Staffordshire, &c., Steam Tramways Co., 1889 (23 Q.B.D. 17), it appeared that an accident was caused by the company's car which ran off the line at a point where that line joined the line of another system, over which the company had running powers. It ran off the line owing to a defect in the points at the junction, but it was not clear whose duty it was to repair the points. It was held that in any event the owners of the car were liable, because their statutory powers did not extend to authorise their running along the highway on a track which was in a defective condition. Again, in an Irish case, a tramway company was held liable for injuries caused by the worn and slippery condition of their track.

Most of the cases in the books which illustrate the liability of tramway companies were decided in relation to trams drawn by horses, but the same principles apply in the case of electric traction. Indeed, it might also be said that an electric tramway company have a greater burden imposed upon them, as the weight and speed of the cars which they use is so much greater than the weight and speed of the old-fashioned tram.

It is first important to consider the position of a tramway company with regard to the highway. Under the Act of 1870, and the provisional order which has been granted to them, they obtain leave to use that portion of the road which lies between the rails and which extends to a distance of 18 in. beyond the rails at either side. This part of the road they have to keep in repair. They also obtain leave to erect posts for the support of the overhead wire which is to be suspended at such a distance above the road metal that it will not interfere with the ordinary traffic in the streets. Regulations have been issued from time to time by the Board of Trade with regard to the use of these trolley wires. It is now proposed to consider some of the more important of these regulations.

Clause XV. of the Form of Regulations made by the Board of Trade and applied to overhead wires is as follows: —"The overhead conductors used in connection with the working of the tramways shall be securely attached to supports, the intervals between which shall not, except with the approval of the Board of Trade, exceed 120 ft., and they shall be in no part at a less height from the surface of the street than 17 ft., except where they pass under railway bridges." Clause XXI. of these Regulations provides that "efficient guard wires shall be erected and maintained at all places where telegraph or telephone wires cross above the overhead conductors of the tramways." In September, 1902, however, the Board of Trade issued the following Regulation to be used in substitution for No. XXI. :—"If and whenever telegraph or telephone wires, unprotected by any permanent insulating covering, cross above, or are liable to fall upon, or to be blown on to, the electric conductors of the tramways, efficient guard-wires shall be erected and maintained at all such places." In an explanatory memorandum which is sent with this proposed clause, the Board indicate the position in which the guard-wire should be placed.

Where trolley wires are uninsulated, and there is no guard wire above them, the breaking of a telephone wire sometimes short-circuits the trolley main. The result is that serious injury is caused by electric shock. In these circumstances it appears, upon the authority of a County Court judge, that responsibility does not rest with the tramway company. In Bedworth & Son *v.* The National Telephone Co., an action was brought against the company for the price of a horse killed by an electric shock. It appeared that a broken telephone wire, which fell on the horse, had short-circuited a trolley wire belonging to the South Staffordshire Tramway Co., who were joined as defendants. The judge held that the telephone company were liable, as they had been guilty of a trespass in allowing their wire to touch that of the tramway company, and he made them responsible in damages.

Owing to a number of accidents which took place at Liverpool from the entanglement of broken telephone wires with trolley wires, the National Telephone Co. brought forward a clause excluding them from liability in such cases, unless it was proved that the escape of electricity was due to the fault of the telephone company. A clause of this kind appeared in the Tyneside Bill of 1901, and a number of others. (See the ELECTRICAL REVIEW, August 23rd, 1901, p. 330.)

In America it was held that where one defendant's wire carrying a dangerous current crossed the other defendant's wire carrying a harmless current, and there were no guards between them, it was held that both defendants might be found guilty of negligence, where an accident occurred owing to a contact of the wires (Rowe *v.* N.Y. and N.J. Telegraph Co. (1901) N.J. 48 Atl. Rep. 523); but it was otherwise where the contact was caused by the fault of the owners of the dangerous wire owing to the slipping of the trolley-pole of one of their cars, or where it was due to the fault of the owners of the harmless wire in suffering it to get out of repair (Western Union Telegraph Co. *v.* Thorn, 1894 (64 Fed. Rep. 287).

The question whether the person who sustains injury can be guilty of contributory negligence which will relieve the tramway company does not appear to have been decided in the English Courts. It is submitted that if a passenger on the roof of a double-decker were to deliberately grasp a naked trolley-wire, or otherwise expose himself to danger in contravention of the notices and bye-laws of the company, he could be found guilty of such contributory negligence, then the tramway company would be relieved. At any rate, the decisions of American Courts could be cited in support of such an argument. In Freeman *v.* Brooklyn Heights Rail-Road Co., 1900 (66 N.Y.S., 1,052), a company was held not to be liable when its guard wire had become charged, and injured a boy who was walking on the girder of a bridge, where he had no business to be, although it was the custom of boys so to walk. There is no contributory negligence, however, if the injured person is under duty to be where he was at the time of the accident, or where a wire is dangerously near a public passage, although the injury was caused by an unusual act on the part of a passer-by.

In addition to the liabilities which they incur to members of the public who may be injured, the company are subject to penalties if they fail to observe the bye-laws already considered. It is provided that the promoters or any company or person using electrical power on the tramways contrary to any of the above regulations are, for every such offence, subject to a penalty not exceeding £10, and also, in the case

of a continuing offence, to a further penalty not exceeding £5 for every day during which such offence continues after conviction thereof.

NEW PATENTS APPLIED FOR, 1904.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

644. "Improvements in and relating to electrical rail bonds." K. R. Stuart, S. Broughton-Halcomb and P. Macgregor. January 11th.

653. "Dynamo casings." Saarbrucker Elektricitats-Aktien-Gesellschaft and J. Emmerich. January 11th. (Complete.)

656. "Electric plug switch." A. Brunton and W. M. Brunton. January 11th.

658. "Improvements in rheostats." W. Fairweather. (The Cutler-Hammer Manufacturing Co., United States.) January 11th. (Complete.)

660. "Improvement in electric alarms." M. Plato. January 11th.

661. "Improvements in and connected with obtaining metals by electricity." J. B. de Alzugaray. January 11th.

674. "Improvements in or relating to gas or vapour electric apparatus." F. W. Le Tall. (The Cooper-Hewitt Electric Co., United States.) January 11th.

692. "High-tension microphone." R. Von Horvath. January 11th.

699. "Improvements in electric stoves and heating and cooking apparatus." J. A. Bauer. January 11th.

707. "Improvements in electric block signalling systems." L. C. Werner. January 11th. (Complete.)

711. "Improvements in controlling devices for electrically-driven vehicles." The Elektrizitats Aktien-Gesellschaft vormals W. Lahmeyer & Co. (Date applied for under Patents Act, 1901, June 22nd, 1903, being date of application in Germany.) January 11th. (Complete.)

716. "Improvements in and relating to the control and propulsion of vehicles propelled by electric motors." J. S. Raworth. January 11th.

758. "Improved process for insulating electrical conductors." W. G. Heys. (W. E. Ammon, United States.) January 12th. (Complete.)

786. "Improvements in and means or apparatus for forming the joints in conduits for electric cables." J. H. Sutton and L. Gregson. January 12th.

789. "Improvements in electric railways." L. W. Pullen. January 12th. (Complete.)

810. "Improvements in or relating to electric automobiles." J. S. Raworth. January 12th.

818. "Improvements in electric railway systems." The British Thomson-Houston Co., Ltd., H. N. Sporburg, F. W. Carter, and A. S. Cubitt. January 12th.

819. "Improvements in and relating to electric motor-control." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 2th.

820. "Improvements in and relating to electric switches and the like." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 12th.

821. "Improvements in systems of electric motor control, and in controlling apparatus therefor." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) January 12th.

822. "Improvements in brush-holders for electric dynamos, motors, and the like." The Phœnix Dynamo Manufacturing Co., Ltd., and H. A. Jones. January 12th.

833. "Improvements on and relating to telephone systems." H. Redmon, R. L. Halls, R. H. Conway, and N. F. Smith. January 12th. (Complete.)

839. "Improvements in the art of electrotyping." J. A. Corey. January 12th.

848. "Improvements in electro-mechanical mechanism for controlling from the moving car or train, the direction of motion and position of movable 'shunting points' in tram or railway lines, and also in the bare electrical conductor from which the electric current is collected for propelling the electric tramcar or train." G. D. A. Parr. January 13th.

850. "X-ray tube for use with alternating currents." A. W. Clayden. January 13th.

869. "Improvements in relays for recording re-transmitting and controlling currents of electricity, and in apparatus therefor." W. E. G. Johnston. January 13th.

880. "Improvements in automatic electric signalling for railways and tramways." T. Thomas, H. Brecknell, E. M. Munro, and H. I. Rogers. January 13th.

952. "Improvements in the means for obtaining power for driving electric motor vehicles." D. Burns and J. M. Fleming. January 14th.

954. "Improvements in variable speed electric motors." H. M. H. Hobart. January 14th.

959. "Improvement of electric testing apparatus." G. C. Geisler. January 14th.

962. "Improvements in induction coils." V. W. Delves-Broughton and J. A. Cole. January 14th.

968. "Improvements in electrodes for electro-chemical processes." R. Threlfall. January 14th.

984. "Improvements in and connected with electrical alarums for clocks and watches." C. B. Sturgess. January 14th.

1,006. "Spark extinguishing apparatus for use in connection with electrical high frequency circuits." A. d'Arsonval. January 14th.

1,011. "Improvements in and relating to electric winches." H. Laing. January 14th.

1,020. "Improvements in and in the manufacture of electric light and other suspension lamps." F. E. Spittle. January 15th.

1,027. "Improvements in electric light switches, electric bell pushes and the like." G. W. Beldam. January 15th.

1,036. "Improvements in accumulators or secondary batteries." T. Pescatore. January 15th.

1,044. "Improved electrical contact maker for gas, oil and all internal combustion engines." A. Alltree. January 15th.

1,050. "Improvements in electric signalling mechanism." P. R. J. Willis. (A. E. Caughey, United States.) January 15th.

1,078. "Improvements relating to automatic electrical switches." C. H. Offord and T. H. Marsh. January 15th.

1,095. "Improvements in apparatus for operating and controlling railway switches and signals." A. Neelemans. January 15th. (Complete.)

1,126. "Improvements in high frequency electric machines." G. B. Batten. January 16th.

1,128. "Improvements in electric light fittings." Veritys, Ltd., and P. G. Ebbutt. January 16th.

1,143. "Improved electric arc lamps suitable for currents of low periodicity." H. Hirst and A. E. Angold. January 16th.

1,145. "Improvements in and connected with adapters for affixing electric incandescent lamps to oil lamps." B. L. Myer. January 16th.

1,176. "Improvements relating to means applicable for use in connection with electric cars, and other vehicles, for stopping the same and for indicating the speed thereof." C. Simmons. January 16th.

1,187. "Electric accumulator plate." C. P. Elieson. January 16th. (Complete.)

1,197. "Improvements in electrical resistances." G. H. Padgham. January 16th.

1,203. "Improvements in electric transmission by three-phase currents for motor vehicles." N. A. Masson. January 16th.

1,205. "Improvements relating to telephone apparatus." K. Höflinger and K. Wolffhardt. January 16th.

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